RAILWAY CONVERTER SUBSTATION

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

1911

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RAILWAY CONVERTER SUBSTATION.

A THESIS

PRESENTED BY

JOSEPH H. JACOBSON

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

ELECTRICAL ENGINEER.

1911.

Approved
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RAILWAY CONTRACTS SUBSTATIONS.

A THESIS

PRESENTED BY

JOSEPH H. JACKSON

TO THE

PRESIDENT AND FACULTY

OF

AUBURN INSTITUTE OF TECHNOLOGY

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INTRODUCTION.

This thesis covers the erection of the building and electrical equipment of a 3-2000 K. W. Railways Converter Sub-Station located at Grand and 40th ave.

The station was designed and erected by the Chicago Railways Co. and the electrical equipment was bought under contract from the General Electric Co. however installed by the Railways.

The building covers an area of 98'6" X 5I'8".

The Sub-Station is divided into two parts, the building and the electrical equipment, the former is designated by Division G and the latter by Division I. As the work progresses, progress reports, engineers material estimates and labor reports are recorded and in this manner they will be found.
Costs of material and labor are not given for obvious reasons.

The K. W. capacity of all the street railways of Chicago can be found in the latter part of this paper.

BOARD OF SUPERVISING ENGINEERS

CHICAGO TRACTION

OFFICE OF THE CHIEF ENGINEER

SPECIFICATION

G - 19

FOR

A FIREPROOF SUBSTATION

FOR

THE CHICAGO RAILWAYS COMPANY

BOARD OF SUPERVISING ENGINEERS

CHICAGO TRACTION

SPECIFICATION

G-19

1. GENERAL

1. SCOPE:

This specification is intended to provide for all labor, tools and materials required in the different branches of work, in the construction of a fireproof substation.

2. WORK NOT INCLUDED:

The following branches of the work are not included in the specification:

(a) Lighting System
(b) Traveling Crane
(c) Lockers
(d) Electrical Equipment

3. DEFINITION OF TERMS:

Whenever the words "Chief Engineer of the Work" are mentioned, they refer to the Chief Engineer mentioned in the Ordinance as having general charge of the work of rehabilitation, or his authorized representative.

Whenever the words "Engineer in Charge" are used, they refer to the Chief Engineer of the Chicago Railways Company for whom the work is being done, or his authorized representative.

Whenever the word "Company" is used, it means the Chicago Railways Company.

Whenever the word "Constructor" is used, it means the Chicago Railways Company, or its duly authorized agent.

Whenever the word "Manufacturer" is used, it means the Company or person furnishing the material specified.

4. INTERPRETATION OF PLANS AND SPECIFICATIONS:

In case of a misunderstanding or disagreement arising between any of the interested parties as to the intent or meaning of the plans or specifications covering the work, or should a question of fact arise as to whether or not the work is being performed in accordance with the plans and specification, the decision of the Chief Engineer of the Work shall be final in all such matters, unless the Board of Supervising Engineers shall, at a subsequent meeting, overrule his decision.

5. CONSTRUCTORS:

The Constructor must read the entire specifications for all branches of the work and carefully examine all drawings in connection with the same, so that he will obtain a clear understanding of the relations between all branches of the work, and he shall so conduct his work as to facilitate the prompt execution of the entire work.

The Constructor shall furnish all labor, false-work, scaffolding, tools, appliances and transportation required, for the full performance of all his work as outlined in plans and specifications. He shall also furnish all materials of every description required for the proper execution of all his work except such materials as may be furnished to him by the Company, in accordance with his contract. He shall lay out his work and be responsible for its correctness; shall keep competent foremen on the premises; shall obtain all the necessary permits to properly carry out the work, paying the lawful fees therefor; shall give to the proper authorities all requisite notices relating to the work in his charge; shall be responsible for all violations of law or damages to property caused by him or his employes; shall keep a watchman on the work at all times when the work it not actually in progress, and must properly protect his work by providing all necessary guard rails, night lights, temporary sidewalks, etc. required for the safety of the public and his men, and indemnify and hold harmless the Company from all damages or losses by reason of Constructor's neglect.

Each Constructor shall so conduct his work that it will harmonize with the work of other constructors and

not interfere with other work going on at the building site at the same time, or with the operation of the Company's cars.

In no case shall any part of the work be sub-let without the written approval of the Chief Engineer of the Work and the Engineer in Charge.

II. LABOR

All workmanship shall be first-class in every particular. Men employed on work requiring skilled labor shall be thoroughly competent and experienced. All work shall be performed according to the drawings and specification, under the direction and to the entire satisfaction of the Engineer in Charge, who reserves the right to request the removal of any particular workman or workmen from the work, if in his judgment it would be to the best interests of the work that they be discharged.

Constructos must carry casualty insurance on all the men employed on work done under this specification, and the Company must be free from harm from any suit or suits for damages arising from accidents occuring during the progress of the work.

III. MATERIALS

All materials and fixtures are to be of the best of their several kinds in quality as herein called for and the Constructor will not be permitted to substitute other materials and fixtures without first having obtained the written approval of both the Chief Engineer of the Work and the Engineer in Charge.

All work and materials must conform to the laws, rules and ordinances of the City of Chicago and its Building Department.

All materials rejected in inspection must be immediately removed from the premises of the Constructor.

IV. DRAWINGS

The drawings referred to in this specification are the following:

NO		TITLE
Sketch E-179	-	Location of Substation
D-1752	-	Foundation Plan.
D-1753	-	Basement Plan.
D-1754	-	First Floor Plan.
D-1755	-	Elevations.
D-1756	-	Northeast and Southwest Elevations.
D-1757	-	General Sections.
D-1758	-	Floor Steel Details.
D-1759	-	Roof Steel and Column Details.
D-1760	-	Terra Cotta Details.
D-1761	-	Cut Stone Details.
D-1762	-	Roof Plan.
D-1763	-	Location of Bracket Bolts.
D-1764	-	Floor Reinforcement.
D-1765	-	Mill Sheet.
D-1766	-	Switch and Bus Bar Compartments.
D-1767	-	Arrangement of Static Discharge Apparatus.
D-1768	-	Conduits and Wiring.
D-1769	-	Window Guards.
D-1770	-	Stair Details.

The above drawings will be supplemented by other scale and detail drawings, to be furnished as the work progresses. All of these drawings form a part of this specification. The Constructor must satisfy himself of the correctness of all drawings before proceeding with any work. Anything which is not shown on the drawings, but which is mentioned in the specification, or vice versa, shall be furnished and performed as though mentioned in both.

V. PATENTS

The successful bidder shall guarantee to indemnify the Chicago Railway's Company, its successors or assigns, for any loss, damage or expense of any suit or suits brought against it for the alleged infringement of United States Letters Patent, and to take charge of and defend any and all such suits without expense to the Chicago Railways's Company, its successors or assigns.

VI. PREPARATION OF SITE.

The Constructor shall remove all obstructions that interfere with the construction of new building. He shall dispose of material removed in a careful manner without expense to the Company.

VII

SPECIFICATION

F O R

MASONARY & CONCRETE

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. GENERAL REQUIREMENTS:

This Constructor shall provide all labor and materials shown, or implied or necessary for the erection and completion of all masonary, plain or reinforced concrete work required in the construction of this building, in accordance with the drawings and as hereinafter specified.

The "General Conditions" given on pages 2, 3, 4, 5, 6 and 48 apply to this branch of the work.

2. EXCAVATING:

Constructor shall excavate to the different depths called for on the drawing and as directed at building, for all footings, piers, retaining and dwarf walls, etc. removing all surplus dirt and material not fit for "filling" from the premises. Excavate for sump, to be located where directed, also for any machinery foundations that may be required.

This constructor is cautioned to notify the Engineer in Charge in any questionable soil is encountered before proceeding with the work. No back filling shall be done until the walls are firmly set, the forms removed and the work has been inspected.

3. GRADING:

Grade the areas outside of building to proper elevations with the top layers of material excavated. Carefully level excavated areas to subgrade for all concrete floors. Where sidewalks occur fill to within 14" below sidewalk grade.

4. WATER SUPPLY:

Hose connections for the supply of all water needed for the construction of the building shall be provided by this Constructor. He will also furnish the necessary pipe and hose to lead the water to points needed and pay the City water tax until completion of building.

5. LIME, CEMENT AND SAND:

All lime, cement and sand for the various purposes mentioned shall be as follows:

LIME: No. 1 freshly burned and thoroughly slacked.

PORTLAND CEMENT: Universal, Lehigh or other brand, freshly made to be approved by the Engineer in Charge and the Chief Engineer of the Work, and to comply with the Standard Specifications of the American Society for Testing Materials.

SAND: To be clean, sharp medium size and free from loam and dirt and thoroughly screened.

6. MORTAR:

All mortar for the various works herein mentioned is to be as follows;

LIME MORTAR: 1 part lime and 3 of sand.

PORTLAND CEMENT MORTAR: 1 part Portland Cement and 3 of sand.

PORTLAND CEMENT AND LIME MORTAR: 1 part Portland Cement, 1 part Lime and 3 parts of Sand. Mortar to be mixed in proportions such as to secure a good working consistency.

All cement and sand for mortar to be thoroughly mixed dry, add only enough water to give mortar a good working consistency. Mortar is not to be made up in greater quantities than required for the work on hand. Mortar left over night is not to be used in any way,. This refers to cement mortar only. No mortar to be retempered or used after initial set has occurred,.

7. CONCRETE FOUNDATIONS:

All foundation footings, walls and piers below grade and other work so shown, shall be of concrete composed of 1 part approved Portland cement, 3 parts clean, sharp and coarse sand and 6 parts broken stone from 1/2" to 1-1/2" in size.

Concrete is to be thoroughly mixed by measure, use enough water to secure a moderately "wet" mix and tamp sufficiently to flush the mortar to the surface, filling all voids. Fill no forms until the same have been inspected by the Engineer in Charge as to dimensions and locations of holes for sewer, water, steampipies, conduits, etc. Note location and sizes of conduit openings shown on drawings. Set in place all bolts for columns, rails and machinery. Keep trenches free of water while placing concrete.

In case of freezing weather this Constructor is to take all such precautions as may be necessary to prevent freezing of concrete.

Hand mixing must be done on a platform built of dressed and matched boards. Cover platform with a layer of stone of even thickness measured for required proportions and mixture.

Place a layer of sand over the stone and spread cement evenly over sand.

Turn the mixture over twice while dry and until all cement streaks have disappeared. Water must be applied slowly and the same amount in each batch. The wet mixture must be turned over not less than twice on the platform and to the satisfaction of the inspector.

8. OUTSIDE FACE BRICK:

The entire exterior of the south and east walls, including all jambs, recessed and projecting portions, etc. are to be faced with an approved red vitrified paving brick, Every sixth course to be a course of full headers. Face brick to return on northeast and southwest walls at corners as shown. Spcial care must be taken in laying up dentil and projecting portions in order to obtain absoultely true lines vertically and horizontally. Thickness of joints, color and quality of mortar, etc., will be subject to approval.

9. WHITE AND GREEN ENAMELED BRICK:

The entire inside face of walls, except inside of office and Toilet room, up to a height of about 4' - 10" above the floor is to have a dado of green enameled brick, to be selected by the Engineer in Charge. The bottom course of dado is to be laid with a course of white enameled brick set on end and laid flush with face of wall. The top of dado to consist of a course of headers set on edge flush with face of wall.

The entire inside face of Front and rear stair walls is to be faced with green enameled brick, except that the stairs and landing, and door opening shall be bordered by white enameled brick.

All quoins in corners and also belt course around sub-station just below the roof line, dropping down and around all roof trusses as shown on drawings, will be of green enameled brick.

The entire remaining surfaces of all interior walls above first floor are to be faced with Tiffany white enameled brick-- American size.

Thickness of joints, color and quality of mortar, etc., will be subject to approval.

Piers for oil switches to be built of green enameled brick.

10. LEMON SPARTA BRICK:

The bus bar structures in basement are to be built solid of Lemon Sparta #2 Waterproof brick, laid in Portland Cement mortar.

All basement walls not otherwise specified are to be built of common brick.

11. COMMON BRICK:

All other masonary called for on the drawings and the backing of the walls faced with paving brick are to be laid to the dimensions shown, of sound, hard burned, merchantable building brick equal in quality to those commonly used in the City of Chicago. All to be laid to a line on both sides, carefully bedded and bonded and to have continuous header courses, of whole brick, every sixth course. Common brick is to be laid in lime mortar unless otherwise noted. Joints must be neatly struck and worked in regular bond.

All walls and piers shall be built plumb and true and come to exact heights and have all necessary flues, recesses for pipes, corbels for beams and floors and openings as shown or directed. No soft or salmon brick shall be used in any part of the work. Carry up walls uniformly all around, so as to bond all steel beams, plate girders and trusses as soon as these are set. Build in anchors of all kinds and iron brackets and back up all cut stone work. Point up close to all walls, copings and projections; bed all frames solidly and underpin all sills after walls have set. The lower eight courses above grade and all walls above roof line to be laid in Portland cement and lime mortar.

Build in all iron work such as angle iron frames for steel door, etc. also wooden brick or blocking for securing frames or other material, to masonary. Set all cast iron or steel plates and copings in Portland Cement mortar. Exact elevations will be given by the Enginner in Charge. Turn arches where needed to relieve span openings without lintels.

12. CONCRETE FLOORS:

After all work under-ground is in place and the sump built, this constructor is to lay a concrete sub-floor 4" thick, composed of 1 part Portland Cement, 3 parts clean, sharp sand and 5 parts of 1" size broken stone. The top surface to be floated smooth enough to admit of laying of the waterproofing without being damaged by sharp stone. After Constructor, for waterproofing has finished his work, this constructor is to lay a 4" concrete floor as above on top of waterproofing, finishing with a 1/2" top dressing of 1 part Portland Cement and 2 parts of sharp sand or granite screenings. Take pains to adhere closely to all grades given by the Engineer in Charge. All ground to be thoroughly tamped and properly prepared before laying floor.

First Floor: Between steel framing of first floor build reinforced concrete floor as shown on drawings. These floors are to have the thickness and shape called for and are to be made of a mixture of 1 part Portland cement, 2-1/2 parts sharp sand and 5 parts 3/4" size broken stone. No forms are to be filled until the Engineer in Charge has been notified and made an inspection to see that dimensions are correct and all conduit openings, etc. are in proper place. This concrete floor is to have top of floated finish, 1" below the line of the finished floor grade, so as to give proper bond to cement base under tile floor.

Concreting in first floor must be stopped each night at such places as directed by the Engineer in Charge.

13. REINFORCING BARS:

Furnish and lay rods for reinforcement of concrete of sizes and shapes called for. The above bars are to pass test as follows:

Ultimate tensile strength not less than 70,000 lbs. per square inch.

Yield point not less than 50,000 lbs. per square inch.

One-half inch rods to bend cold through 180 around three diameters without showing fracture on outside of bent portion.

Other rods to bend cold through 180 around six diameters without showing fracture on outside of bent portion.

Variations in weight not to exceed 2%

Furnish certified copy of mill test.

All bars bent on the work must be bent cold.

14. BOOK TILE:

Furnish and set in place on all roofs including roofs of Toilet Room and Office 3' X 12" X 18" semi-porous book tile supported on steel T's. Joints between tile shall be of cement mortar mixed in proportions of one part of Portland Cement to two parts of clean, sharp sand.

15. ROOF SADDLES:

Build saddles on roof as shown so as to turn water to down-spouts. All saddles to be made of cinder concrete, composed of (1) one part Portland Cement Mortar, (3) three parts clean, sharp torpedo sand and (5) five parts coal cinders and laid perfectly smooth and properly pitched.

16. SETTING CUT STONE:

This Constructor will carefully set in place all cut stone work called for in the drawings. All to be properly bedded in lime mortar. Do not set any stone having imperfections or damaged in any way. All cut stone must be delivered clean and whole upon the completion of the building.

17. SETTING TERRA COTTA:

This Constructor is to set all terra cotta coping, cornice, etc., called for on the drawings. Use cement mortar colored to match terra cotta for setting of same. Do not set any terra cotta having imperfections or damaged in any way. All terra cotta must be delivered clean and whole upon the completion of the building.

18. COPING :

This Constructor is to furnish and set #1 vitrified salt-glazed tile coping, as called for on the drawings, Use cement mortar for setting of coping.

19. TESTING CEMENT:

Portland Cement shall conform to the Standard Specifications adopted by the American Society for Testing Materials.

All cement is to be inspected either at the place of manufacture or on the work. In order to allow ample time for inspecting and testing, this Constructor is to provide a suitable weather-tight building, having the floor properly blocked or raised from the ground.

20. MISCELLANEOUS:

This Constructor shall provide all necessary plank floors placed where required in the building for the storage of his materials, and for protection of workmen, as called for in Building Ordinances.

The carpenter will provide and set all wood frames, centers, etc., but the mason shall assist in setting them and see that they are correctly in place before proceeding with his work. All frames and beams shall be set as the walls go up.

The frames to be well stayed and braced while being built in. Build in and back up all sheet metal and other materials, wherever necessary, and assist all other Constructors in the performance of their work wherever the same comes in contact with the masonary. All walls must be cleaned both inside and outside of all mortar stains, droppings and projecting mortar joints, upon completion of building. Care must be used in applying muriatic acid not to injure stone work.

All cut stone and terra cotta must be properly pointed up and washed down by this Constructor.

21. FLUE LININGS:

Build smoke flue where shown, of sizes indicated and line from top to bottom with hard-burned terra cotta flue lining, joints bedded in cement mortar neatly pointed up and made perfectly tight. Flue is to be built up with brick walls, the brick work of same being laid in lime mortar to the roof; above the roof use cement mortar. Build 8" X 8" iron soot door into wall at base of flue and thimble for smoke flue. Constructor to furnish the above door, frame and thimble.

22. REINFORCED CONCRETE STAIRS:

At front and rear entrances of substation build reinforced concrete stairs and landings as shown on drawings and reinforced with steel as noted. Build reinforcing steel into brick wall and concrete floor so as to provide good and sufficient anchorage for stairs when built. Stairs to be built of concrete composed of one part Portland Cement, 2-1/2 parts clean, sharp sand and 5 parts 3/4" size broken stone. All exposed parts of stairs to be made with a mortar of 1 part Portland Cement and 2 parts of clean, sharp sand.

Each tread of stairs to have a 6" mason tread embedded in the concrete.

VIII

SPECIFICATION

FOR

WATERPROOFING

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAY COMPANY

1. SCOPE:

This specification is intended to cover all labor and material necessary to construct a waterproof envelope under the basement floor and under and around all exterior concrete foundation walls of the building up to the height of and underneath the watertable.

The "General" Conditions given on pages 2,3,4,5,6, & 48, apply to this branch of the work.

2. ORDER OF PROCEEDURE:

Special attention is called to the fact that this work will have to be done in sections and at different times about as follows:

1. Waterproof on top of footing courses of exterior and rotary walls as these are completed.

2. Waterproof outside walls when these are completed up to and underneath watertable and connect with projections left on top of footing courses.

3. Waterproof on top of subfloor and connect with projections left at footings of piers and walls.

3. MATERIAL:

The felt used on this work is to weigh not less than fourteen (14) lbs. per 100 sq. ft., single thickness and to be thoroughly impregnated with a compound known as "Barrett's Specification Pitch". No other compound may be used unless the written approval of the Engineer in Charge

has first been obtained. In cold weather one (1) barrel of tar must be mixed with each five (5) BBLS. of pitch to prevent the compound from freezing too rapidly.

4. METHOD OF APPLICATION:

The Mason will furnish all surfaces to be waterproofed with a smooth float finish, but the Constructor for this work will be held responsible for any projections which may injure the felt. Promptly report any defects in float as left by Mason, to the Engineer in Charge.

The cement finish must first be mopped uniformly with the compound above mentioned, after which five (5) layers of felt must be put on, with solid mopping between each layer. The top surface is to be doubly mopped and after drying, to be sprinkled with sifted sand.

Where concrete walls are to be built on top of waterproofing, clean surface thoroughly and mop solid with compound just before pouring concrete.

All felt under footings, piers and walls must project at least 6" to allow for making connections with rest of envelope, to be placed later on. In all special cases such as under conduits, etc., great care must be exercised to prevent the top edges from being broken off, also around all openings in the walls, where pipes or conduits leave the building, the connection to same must be extra mopped and the edges of the felt carefully turned in.

The felt on outside walls is to be turned in under the stone watertable a distance of at least six (6) inches.

Any holes which may be found in the felt, caused either by poor material or by the carelessness of workmen, shall be patched with five (5) layers of felt all thoroughly mopped same as described for walls and floors.

Consult with Engineer in Charge before proceeding with any unusual work around conduits, piers, etc,, and secure his approval. In no instance is one layer of felt to touch another layer of felt. Each layer must be entirely surrounded by compound as described above.

5. GUARANTEE

Furnish written guarantee covering all work mentioned herein for period of five (5) years.

IX.

SPECIFICATION

F O R

CUT STONE

F O R

A FIREPROOF SUBSTATION FOR THE

CHICAGO RAILWAYS COMPANY

1. GENERAL REQUIREMENTS:

This constructor shall furnish all cut stone indicated at various places on the drawings and consisting of water table and belt courses, window sills and trimmings. Submit four sets of details and setting diagrams for approval before cutting same, two copies each to the Engineer in Charge and the Chief Engineer of the Work.

The "General Conditions" given on pages 2, 3, 4, 5, 6 and 48, apply to this branch of the work.

2. KIND AND QUALITY:

All of the cut stone herein contemplated shall be of first quality, selected Buff Bedford, or Blue Bedford stone, absolutely clear and uniform in color, free from cracks, seams or imperfections of any kind. All cutting of the work shall be done as much as possible before delivery. Constructor must remove all excess stone and chips of every kind from the premises, repairing all damages that may be done during the execution of the work.

3. SURFACE FINISHING:

All portions of the cut stone are to have their surfaces rubbed smooth.

4. JOINTS:

All horizontal and vertical joints are to be uniformly 1/4" in width and all cut stone to be thoroughly bedded and set in lime mortar by the Mason and set level and plumb, provided with the necessary clamps, dowel or Lewis holes and all surfaces neatly finished as above specified.

5. SILLS:

All sills for upper windows are to be lug sills. Every sill is to be grooved for water bar.

6. SETTINGS, DIAGRAMS, ETC.

All of the cut stone required for the complete building must be furnished by the constructor as fast as required, accompanied by explicit setting diagrams, showing correct location of all pieces. The setting of all cut stone will be done by Mason who will also point up and clean the work after completion.

7. FINAL:

All material and workmanship differing in any respect from that shown on drawings or called for in specification is to be removed, remade and replaced and all other work thereby injured or destroyed must be made good at this Constructors expense.

All stone must be unloaded where directed, in perfect condition without flaws of any kind. No stone that is chipped, marked or defective in any way will be accepted.

X

SPECIFICATION

FOR

ARCHITECTUAL TERRA COTTA

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. GENERAL REQUIREMENTS:

This Constructor shall furnish all architectural Terra Cotta indicated at various places on the drawings and consisting of copings, wash for cornice and other trimming. Submit full size detail of all work for approval before manufacturing same. Two copies each to the Engineer in Charge and the Chief Engineer of the Work.

The "General Conditions" given on pages 2, 3, 4, 5, 6 & 48 apply to this branch of the work.

2. KIND AND QUALITY:

All of the Architectural Terra Cotta herein contemplated shall be of first quality, uniform in color, free from cracks, or other imperfections of any kind, true to details and provided with holes for anchor rods where necessary.

3. SURFACE FINISHING:

Submit samples of color and finish for approval of Engineer in Charge and Chief Engineer of the Work before starting to manufacture.

4. SILLS:

All window sills are to be of the section called for on drawings with roll to protect all joints. Provide groove for water bars in all sills.

5. FINALLY:

All material and workmanship differing in any respect from that shown on drawings or called for in Specification

is to be removed, remade and replaced and all other work thereby injured or destroyed must be made good at this Constructor's expense.

All Terra Cotta must be unloaded where directed, in perfect condition, without flaws of any kind. No Terra Cotta that is chipped, marked or defective in anyway will be accepted.

XI.

SPECIFICATION

FOR

STRUCTURAL STEEL & IRON

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. WORK INCLUDED:

Furnish and erect all the structural steel and iron work shown on the drawings herein mentioned, together with all the necessary connections, bearing plates, bolts and rivets and filed rivets and bolts.

Include all steel and iron shown or called for on drawings Nos. D-1758 and D-1759, together with cast iron columns and trench covers.

The "General Conditions" given on pages 2, 3, 4, 5, 6, and 48 apply to this branch of the work.

2. DRAWINGS:

Carefully check all of the above mentioned drawings and promptly report any omissions or inaccuracies. Furnish 4 sets of detail drawings, two sets each to the Engineer in Charge and Chief Engineer of the Work; secure approval of both before commencing shop work.

3. MATERIALS:

All materials used in this work shall comply with the Manufacturer's Standard Specification on pages 219 to 228 of Carnegie Pocket Book - edition of 1907.

Medium steel shall be used for all trusses, girders, beams and columns.

Soft steel shall be used for all rivets.

All cast iron shall be tough gray iron, free from injurious cold shuts or blow holes, true to pattern and of workmanlike finish. No column or other castings whatever will be accepted unless conforming with above specifications. If castings are such as to require machine work in order to meet specifications, same shall be furnished without extra cost to the Company.

4. CONNECTIONS:

The drawings show all special and important connections. Where no details are given, use Carnegie Standard Connections.

5. TRUSSES, GIRDERS AND COLUMNS:

All riveted members must be accurately punched and free of kinks or twists. Care must be used in unloading.

6. CLEANING AND PAINTING:

Before being delivered on the ground, all material must be thoroughly cleaned of dirt, grease, loose scale and rust, with wire brush. Paint all one coat before delivery to the building. Surfaces inaccessible after assembly are to be painted before being assembled. The paint used shall be red lead with not less than 25 lbs. of red lead per gallon of pure boiled linseed oil or a prepared graphite paint of pure graphite ground in oil of quality equal to Dixon's Graphite Paint or Detroit Superior Graphite Paint. Paint to be used shall be approved by the Chief Engineer of the Work before being applied. All paint must be well worked into all joints and open spaces.

7. INSPECTION AND TESTING:

Make thorough inspection of all material and furnish, if required, certified copies of mill tests. Material shall be straight, true to section with clean surface and free of any cracks, seams or buckles.

The Engineer in Charge and the Chief Engineer of the Work reserve the right to reject any work that may be shown to be defective, or not in accordance with the specification, and same shall be properly replaced by this Constructor without additional expense to the Purchaser,

This Constructor is to furnish the above mentioned Engineers or their authorized representatives every facility for shop inspection.

8. ERECTION:

This Constructor shall erect all the work herein specified to be erected by him. He shall deliver all the material to the building site at the earliest possible date, and shall co-operate with the General Constructor for the building in regard to the erection of same. He shall in every way conduct his work so as to harmonize with that of other constructors so as to insure the earliest possible completion of the work. He shall carry out his work in such a manner as shall meet with the entire approval of the Chief Enginner of the Work and the Engineer in Charge.

9. GUARANTEE:

This Constructor shall guarantee his work against all defects of material and workmanship that may develop within one (1) year after the completion of the work.

XII

SPECIFICATION

FOR

IRON STAIRS AND ORNAMENTAL IRON

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. WORK INCLUDED:

The work intended to be covered by this specification includes all iron stairs, complete with stringers, risers, treads, newels and hand rails, all cast iron facias in stair wells, all window grills with screens and frames for same, and kick plates on doors. Also ladder to crane.

The "General Conditions" given on pages 2, 3, 4, 6, 6 and 48, apply to this branch of the work.

2. STAIRS:

There are two (2) stairways, will all necessary railings and etc., which this Constructor is to furnish and erect complete.

Steel: Furnish standard 10" channel stringers and anchors, all as shown on drawings. Stair will be built with steel angles supporting treads. These angles to be as shown.

Cast Iron: Provide cast iron treads and risers. Treads to be 5/8" thick and risers 3/8" thick, and bolted together with 3/8" tap screws. Treads to have 4" chase for safety tread, as shown,.

Newels: Provide all cast iron newels shown on front and rear stairs. These are to be as per detail and to have metal 3/4" thick. Bolt securely to stringers or floor.

Hand Railing: Provide hand railing for front and rear stairs and well openings, as shown, with vertical bars securely and accurately riveted into channels at top and bottom and channels bolted to stair stringers, newels, or cast iron facias or channels.

Safety Tread: Each tread of all stairs to be provided with a "Mason" or "Carborundum" Safety Tread of 8" less length and 4" wide as shown on drawing.

Concrete Stairs: Furnish cast iron treads with safety treads embedded and cast iron risers for all concrete stairs, as shown on drawings.

3. WINDOW GUARDS:

All basement windows are to be provided with wrought iron window guards, set in steel frames, all as indicated on drawing. Include anchor bolts, hinges and chain with bolt for locking. All basement windows except battery room windows, to have screens as shown on drawings.

Guards are not to be furnished and set until exterior walls are finished.

4. KICK PLATE:

Equip front door with a cast brass kick plate 10" high having a combed surface.

5. PAINTING:

Stairs - the back of stringers and cast iron treads of front and rear stairs are to receive two coats of graphite paint.

The window and door frames and grilles are to be dipped in red lead, having not less than 25 lbs. red lead per gallon of pure linseed oil. After erection these are to receive a good coat of approved black graphite paint.

XIII

SPECIFICATION

F O R

STEEL ROLLING DOOR

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. WORK INCLUDED:

Furnish and erect in place a galvanized steel rolling door in door opening in northeast wall of the sub-station building.

The "General Conditions" given on pages 2, 3, 4, 5, 6 and 48 apply to this branch of the work.

2. DRAWING AND MEASUREMENTS:

This Constructor is referred to drawings Nos. D-1754 and D-1756, which show exact size of opening and steel work at jamb. Accurate measurements must, however, be made at the building and all work so made and erected that the door will fit opening snugly and work without binding.

3. DOOR:

The door is to be "Standard Hand Operated", by means of a strong galvanized iron or steel chain. Use #22 U. S. gauge steel for slats and provide cast edges to take wear in guides.

Cover roll with galvanized iron hood, securely fastened in place.

All work must pass the inspection of the Chicago Board of Fire Underwriters and their written acceptance of same shall be furnished.

4. PAINTING:

Give door one (1) coat of red lead paint before delivery at the building. Door and door frames to be dipped in red lead paint, having not less than 25 lbs. red lead per gallon of pure linseed oil. After erection, door is to receive a good coat of approved black graphite paint.

5. GUARANTEE:

Furnish written guarantee against all defects from poor workmanship or material which may develop within one (1) year.

XIV

SPECIFICATION

FOR

CARPENTRY

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. GENERAL REQUIREMENTS:

The work intended to be covered by this specification consists of all form work, airlock, entrance and other doors, timber under switchboard, tool cabinets, work bench, telephone booth, setting of all frames, etc., and miscellaneous carpenter work throughout the building - all in accordance with the drawings and as hereinafter specified.

The "General Conditions" given on pages 2, 3, 4, 5, 6, and 48 apply to this branch of work.

2 LUMBER:

All of the lumber of the various kinds and grades called for on this specification, except lumber for forms, is to be thoroughly seasoned and dried, either in the open air or by kilns or both. By thoroughly seasoned, as here used, is meant the seasoning or drying throughout the entire section of the various sizes, delivered in a manner equal to the best which the market affords. All finishing lumber must be thoroughly seasoned and kiln dried and where finished in the natural wood, shall be selected and matched for evenness of grain. All lumber shall be of the grades hereinafter specified and free from knots, sap, splits, shakes or other defects foreign to their respective grades.

3. FORMS:

This Constructor is to furnish and erect in place all forms for foundations and floors.

Foundation forms to be made of 2" plank, dressed on one side and securely braced and wired or keyed to prevent bulging. Particular attention is called to the accuracy with which all openings in exterior and rotary walls must be located. All these openings must be carefully checked by the Engineer in Charge before concrete can be placed.

First Floor Forms: All forms for first floor concrete are to be suspended from "I" beams. No posts to floor are to be used. For girder side or bottom, use 2" thick hemlock dressed on one side. These are to be securely fastened to prevent tipping when filling on one side only. Beams for support of floor slab are to be made of 2" hemlock.

4. DOORS AND DOOR FRAMES:

Build doors as shown on drawings. Airlock doors are 2-1/4" thick and of oak on white pine core. Entrance door 2-1/4" thick, solid white pine. Toilet room door 1-3/4" thick, oak veneer on white pine core.

Door frames to be exactly as shown on drawing.

5. INTERIOR CABINET WORK:

Build Tool Cabinet, Work Bench, Telephone Booth, etc., all as shown on detail drawings.

All work included under the heading is to be a high grade of cabinet work, and must be executed exactly according to full size details which will be furnished later on. Note especially that no metal work or hardware can be left exposed on interior of battery cabinet.

6. HARDWARE:

All of the hardware of every description required for the full performance of all the work under this contract, including nails, screws, bolts, etc., also all finishing hardware shall be furnished, paid for and put up by this Constructor. The finishing hardware will be selected by the Engineer in Charge at a cost to this Constructor of $100.00 for the building. Any difference in cost to be added or deducted.

7. MISCELLANEOUS:

This constructor is to have at all times men upon the work who will attend upon the masons for the setting of all door and window frames, wood blocks, centers, sub-sills, lintels, etc., and he will be required to furnish lumber for braces in connection with this portion of the work. Do any and all cutting, fitting and carpentry that is necessary to prepare for the work of other constructors. Properly secure and cover up all project-

ing cut stone that might be injured in any way and attend to all other constructors in the performance of their work wherever the same comes in contact with carpentry. Build and maintain at least two (2) temporary ladders to reach all stories for general use, also walks and temporary enclosures and guards at openings to keep out and protect the public as required by law and the requirements of the work.

8. GUARANTEE:

Furnish written guarantee against all defects from poor workmanship or material which may develop within one (1) year.

XV

SPECIFICATION

F O R

ROOFING

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY

1. WORK INCLUDED:

The roof to be covered is the entire area of the substation building, deducting for skylight.

The "General Conditions" given on pages 2, 3, 4, 5, 6, & 48 apply to this branch of the work, with the exception of "Guarantee" clause. See special guarantee for this work herein contained.

Cover book tile roof with a five (5) ply, coal tar pitch, felt and gravel roof. The tarred felt shall be best quality wool felt weighing not less than fifteen (15) lbs. per one hundred square feet, single thickness.

The pitch shall be coal tar pitch, brand to be approved by the Engineer in Charge and there shall be used not less than two hundred (200) lbs. per one hundred square feet of completed roof.

The gravel shall be of such a grade that no particles shall exceed five-eights (5/8) of an inch or be less than one-quarter (1/4) of an inch in size. It shall be dry and free from dust. In cold weather it must be heated immediately before using. Not less than four hundred (400) lbs. of gravel shall be used per one hundred square feet.

First coat book tile with hot pitch mopped on uniformly. Over this coating of pitch lay two thicknesses of tarred felt, lapping each sheet seventeen (17) inches over the preceeding one and mopping back with pitch the full width of each lap.

Over felt so laid spread a uniform coating of pitch mopped on, Then lay three (3) full thicknesses of tarred felt, lapping each sheet twenty-two inches (22) inches over the

preceding one.

When the felt is thus laid, mop back with pitch the full width of twenty-two (22) inches under each lap. Then spread over the entire surface of roof a uniform coating of pitch into which, white hot, embed slag or gravel. All joinings along wall to be carefully made and connected to 1-1/4" X 1-3/4" wood strips built in walls.

After three (3) months, this Constructor shall recoat the entire roof as follows: Sweep up all loose gravel into piles. Coat entire surface of roof with a heavy coat of pitch and gravel of kinds specified above. This recoating shall not be done until the Engineer in Charge has been notified. The inside surface of all parapet fire walls above roof line shall be mopped with one (1) heavy coating of coal tar pitch, using not less than forty (40) lbs. per one hundred square feet.

2. GUARANTEE:

Furnish a written guarantee covering this work for five (5) years.

XVI

SPECIFICATION

F O R

METAL WINDOWS & SHEET METAL WORK

R A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. SCOPE:

This specification is intended to cover all labor and materials in connection with the manufacture and erection of skylight and flashing for same, and of galvanized iron frames and sash for all window openings in the outside walls of this building. Glazing of sash included in specification Section XVIII "Glazing" page

The "General Conditions" given on pages 2, 3, 4, 5, 6, & 48 apply to this branch of the work.

2. FRAMES & SASH:

All frames to be of #22 galvanized iron, and all sash to be of #24 galvanized iron and all to be painted one (1) good coat of approved red lead paint before delivery.
Frames are to be made strictly according to dimensions shown on drawings.

3. OPERATING DEVICES:

The Constructor for this work is not to include any operating devices. He is, however, to equip all basement windows and clere story windows with fusible link and chain, so arranged that these may be opened by hand whenever wanted, but will close automatically in case of fire. The basement windows are to have one (1) sash pivoted at center. The clere story windows have two (2) sash with top sash pivoted.
The operating device for the large windows and balance of clere story windows will be furnished by others, but thie Constructor is to have the sash hinged as called for and all the necessary lugs on the same, so arms for

operation will simply have to be attached.

The operating device is to be "Ideal" or equal fixture, to be selected by the Engineer in Charge. The clere story windows of the two walls are to work in unison from one bar,. Each horizontal row of sash of large window to work in unison. There will be three (3) handles for operating each complete large window.

4. SKYLIGHTS:

Skylight is to be built as shown, of #24 gage galvanized iron and 1/4" factory ribbed wire glass as hereinafter specified.

Skylight bars are to be built up with condensation gutters with proper outlet drain holes at curb.

Bars shall be securely fastened to sheet metal curbs strongly secured to steel curbs.

Parts of skylight, inaccessible after erection, shall receive one good coat of mineral paint at the shop.

5. FLASHING:

This constructor shall flash all skylight curbs down and well over composition roof with No. 24 gage galvanized iron, all securely fastened in place in good workmanlike manner. Counter flash all roofs at parapet walls with No. 24 gage galvanized iron.

6. GLAZING OF SKYLIGHT:

This Constructor shall furnish and put in place all glass in connection with skylight, heretofore specified. All glass shall be full 1/4" factory ribbed wire glass; same to be set with putty or other suitable materials, as required for the different types of construction, and all skylight glass, properly secured with covering bars. In all cases the ribbed side of glass shall be on inside.

All cracked or otherwise defective glass must be replaced and the entire work left in sound and perfect condition.

7. REQUIREMENTS:

The windows on northeast side of building when completed are to meet the requirements of the National Board of Fire Underwriters, as regards the construction of same.

8. ERECTION:

After delivery at the building this Constructor shall set the windows, but other parties will fill mullions, sills and transom bars with Portland Cement grout. Before being set, the sides of metal work coming in contact with brickwork are to be given a heavy coat of graphite paint, by this Constructor.

Skylight shall be furnished and erected by this Constructor.

9. GUARANTEE:

The Constructor shall guarantee his work against all defects from poor workmanship or material which may develop within three (3) years.

XVII

SPECIFICATION

F O R

PLASTERING

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. GENERAL REQUIREMENTS:

Carefully examine all partitions, outside walls, ceilings, etc., before proceeding with the work, to ascertain whether all angles and surfaces are plumb, vertical or level; also see that all strips and frames are firmly secured. Notify the proper parties to make good any defective work, as this Constructor will be held responsible for all surfaces that are out of plumb, out of level or uneven.

The office and toilet room shall have plastered walls and ceilings.

The outside brick walls and ceilings shall have 3/4" metal furring strips, and metal lath where same are plastered.

The "General Conditions" given on pages 2, 3, 4, 5, 6, and 48 apply to this branch of the work.

2. THREE-COAT PLASTER:

All furred walls and ceilings throughout are to be lathed with #24 galvanized expanded metal or wire lath.

On all walls and ceilings of office and toilet room apply a scratch coat of prepared hard plaster, following after same is sufficiently dry with a browning coat, using enough to fill out and to make all surfaces straight and all angles true.

After browning coat has become dry and set, cover all stained portions with a coat of shellac before applying final coat of plaster.

The final or skim coat of plaster shall be trowelled true and have rough sand float finish of prepared hard plaster.

3. PLASTER:

All plaster shall be "Adamant" or a prepared hard plaster equal to same. Brand to be approved by the Engineer in Charge.

All shall be in original packages, when delivered at the building.

4. PATCHING AND CLEANING:

Do all patching of plastering required after the other mechanics have finished repairing all cracks or broken places, and leave the plaster in a neat and clean condition.

This Constructor is to remove all debris incident to his work from time to time, and cover and protect all work liable to damages.

XVIII

SPECIFICATION

F O R

PAINTING

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. IN GENERAL

This specification is intended to cover all labor and material required in painting the different parts of this building. Tha parts to be painted consist of all steel and iron work throughout the building, such as trusses, crane, crane runway, iron doors, metal windows and window grilles; all wooden doors and other woodwork throughout the building; all book tile ceiling and white-washing in the basement,.

The painting of electrical apparatus and machinery is not included.

The "General Conditions" given on pages 2, 3, 4, 5, 6 & 48, apply to this branch of the work.

2. EXTERIOR WORK:

All exterior woodwork consisting of main doors and frames is to have knots thoroughly shellaced and to receive two (2) good coats of oil paint in addition to priming coat. Color of final coat to be approved by the Enginner in Charge.

All exterior iron and metal work, such as metal windows, rolling steel door, window grilles, bumpers are to be painted two (2) good coats. The first to be graphite and the second a good coat of standard green.

3. INTERIOR WORK:

All iron work which is to be fireproofed, wholly or in part, and all other exposed iron work, including steel columns and trusses, purlins, etc., are to receive a coat of graphite, and all exposed work an additional coat of standard green.

All woodwork (except oak doors and frames which are to be varnished) is to be painted a coat of lead and oil and a coat of standard green.

4. CEILING:

The book tile ceiling is to be painted on underside four (4) coats as follows: One coat of sizing and three coats of best quality ochre and load in oil, tinted to shade approved by Engineer in Charge.

5. WHITEWASHING:

All exposed walls and ceilings of basement, except pressed brick piers and the bus bar structure, are to be given two more coats of cold water paint.

XIX

SPECIFICATION

F O R

GLAZING

FOR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. GENERAL REQUIREMENTS:

Furnish and set all the glass of the several kinds shown on drawings or as hereinafter specified.

All glass must be clear, free from blisters, smoke stains, flaws, or imperfections of any kind.

All glassshall be cut, set, back puttied, sprigged and face puttied and all left clean, whole and in perfect condition upon completion of the building.

All glass broken during the process of construction, from whatever cause, shall be removed and replaced with new glass at this Constructors' expense, however, if the party responsible for such breakage can be found, the charges shall be placed against such party.

The "General Conditions" given on pages 2, 3, 4, 5, 6 and 48, apply to this branch of the work.

2. GLASS:

Entrance door to be glazed as shown on detail.

All glass for metal windows in outside walls to be one-quarter (1/4) inch factory ribbed wire glass.

Office door to be glazed with Florentine glass.

XX.

SPECIFICATION

F O R

SEWERAGE & PLUMBING

FOR A FIREPROOF SUBSTAION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. WORK INCLUDED:

Furnish and install all sewer pipe complete with manholes, catch basins, etc., and connect same with sewer, also all water piping and all plumbing fixtures shown on plans herein called for.

The "General Conditions" given on pages 2, 3, 4, 5, 6, and 48, apply to this branch of the work.

2. SPECIAL CONDITIONS:

This Constructor is to make application and pay for all necessary permits. The plumbing Ordinances and the Regulations of the Street, Sewer, Water and Health Departments of the City of Chicago, shall be strictly complied with in every respect and are made a part of these specification.

3. EXCAVATING:

This Constructor shall do all the necessary excavating for sewer, soil, drainage and water pipes, also for all catch basins and manholes, etc., All trenches must be shored where necessary. Care must be taken in excavating that walls and footings are not injured in any way. Where pipes pass through walls, proper openings will be left by Mason. This Constructor is to co-operate with Mason to insure that all openings are left at proper elevations.

4. CATCH BASINS, MANHOLES AND SUMP:

Build these as shown on plans and details, to be of such inside diameter and depth as shown on detail drawings or as may be required by the City Ordinance. Foundations to be of concrete composed of one part American Portland Cement of approved quality, two parts clean, sharp sand and four parts broken stone or gravel. Concrete to be 8" thick and to project 6" beyond outside face of walls. Walls to be 8" thick and built of selected hard, well burned sewer brick. Sewer brick will be laid up in cement mortar composed of one part American Portland Cement, to three parts of clean, sharp sand. Brickwork to be laid up with solid joints. The invert of inlet and outlet pipes must be formed in foundation. Inside of all catch basins and manholes to be smoothly plastered with Portland Cement to such heights as may be directed. Cement coating must not be less than 1/2" thick and composed of one part American Portland Cement and two parts clean, sharp sand. Top of all catch basins, manholes, and sump must have standard corporation cast iron manhole curb and cover. Cover to be solid or perforated as selected.

5. TILE SEWERS:

Under area of basement floor, lay 4" and 6" drain tile runs as shown on drawings. These runs to be of unglazed drain tile.

Lay tile runs outside of building and connect with street sewer, as indicated. All these except drain tile to be of the best quality, salt glazed, vitrified hub joint sewer pipe of sizes marked on plans.

All pipe must be laid to such grade as directed, and joints made tight with neat American Portland Cement. Bells to be sunk below the general level of the trenches to admit of a solid bearing for pipes. Cleaner to be run through every length of pipe as it is laid.

6. COLD WATER SUPPLY:

From nearest street main run 1" wrought iron main to toilet room, with branches, risers and laterals, as shown on drawing. These pipes to be best quality, standard galvanized wrought iron pipe with malleable galvanized fittings.

Furnish and install a gate valve on branch to toilet room and also all sill cocks called for. See under "Fixtures" for proper size supply to closet tanks, lavatory and slop sink.

Furnish and install meter, as required.

Furnish and install two sill cocks with hose connections located where directed by the Engineer in Charge.

7. DOWN SPOUTS AND SOIL PIPE:

Run lines of 4" extra heavy cast iron soil pipe from foot of down spouts and connect to tile sewer outside of building.

Down spouts will be of 4" wrought iron pipe with screwed fittings connected to cast iron intakes at roof and to cast iron sewer under basement floor. Provide "Y" fittings with brass screw plug for clean-out at foot of each down spout.

Run also lines of 4" extra heavy cast iron pipe from toilet room and connect to tile sewer outside of building.

8. VENTILATION PIPE:

Must be heavy cast iron pipe of size shown, and increased and flashed as specified for soil and waste pipe. The lower ends of the ventilation pipes must be joined to soil and waste pipes by means of "Y" fittings and 45 degree ells, so that there shall be a perfect circulation of the air through the system, and must be installed according to City rules.

9. VENTILATION TRAPS:

Traps of each fixture must be ventilated separately at the crown of same, and as per City Ordinance.

All of the foregoing cast iron, soil, waste and ventilating pipes, to be coated with ashhaltum, inside and out. All must be extra heavy cast iron pipe with extra heavy fittings and of sizes as marked on plans.

10. FIXTURES:

Fixtures are called for by numbers from J. L. Mott Iron Works Catalogue "A". Goods of other manufacture than those designated by catalogue numbers and cuts

may be substituted, if approval of both the Engineer in Charge and Chief Engineer of the Work is first obtained.

11. CLOSET:

Furnish and connect as shown and directed, one (1) J. L. Mott Iron Works Compacto water closet complete, as shown and described on Plate 5057-A, with varnished oak seat and cover, oak cistern, N. P. brass brackets, flush pipe, chain and pull and brass floor flange. Flush tank to be fitted with 1/2" supply.

12. LAVATORY:

Furnish and connect where shown one (1) Veritas vitreous lavatory, as shown and described on Plate 4311-A, with integral back and wall support, patent overflow, N. P. faucet, N. P. trap to wall, plug and chain. Lavatories to have 1/2" supply.

13 SLOP SINK:

Furnish and connect where shown, one (1) L. Wolff's Monarch Porcelain slop sink, galzed outside, and Monarch Porcelain Trap Standard with brass vent connections, black finish, to wall and a polished brass waste strainer, slop sink to have 1/2" supply pipes.

14. PAPER ROLL:

Furnish and set in place one paper roll as described in J. L. Mott Iron Works Catalogue. Plate 3631-A, for water closet as directed.

15. SOAP FIXTURES FOR TOILET ROOMS:

This Constructor is to furnish and put in place soap fixture for lavatory in Toilet Room. Soap Fixture is to be selected by the Engineer in Charge at an approximate cost of $1.00.

XXI.

SPECIFICATION

FOR

HEATING

OR A FIREPROOF SUBSTATION TO BE ERECTED FOR THE CHICAGO RAILWAYS COMPANY.

1. WORK DEDUCTED:

Furnish and install heating apparatus with all connections, steam piping, radiators and smoke flue to stack, complete and ready for use.

The "General Conditions" given on pages 2, 3, 4, 5, 6, & 48, apply to this branch of the work.

2. DETAILS OF CONSTRUCTION:

The steam supply and returns shall be run on ceiling of basement, and supported from same by wrought iron hanger. All piping must be so run that no part of same will come in contact with any of the cables, wiring or apparatus of substation. The Constructor is to use the two pipe system, and to be so arranged that any radiator may be shut of without interfering with the circulation in the others or in the main steam pipes.

3. BOILERS:

The boilers to have a rated capacity of not less than 1600 sq. ft. of radiation and to be of the "Columbia" or "Magee" pattern, or equal. Boiler to be placed where shown on plans, and if any foundation is required same shall be furnished by this Constructor.

The boiler is to be equipped with all necessary castings and trimmings, including altitude gauge, steam gauge, etc. and all necessary tools.

Smoke, Water and Drain Connections: The boiler is to be connected to the chimney with a #18 galvanized iron smoke pipe, securely fastened in place and fitted with a hand damper.

Make proper water and drain connections, using stop cock and check valve on the water supply, also make connections to the sewer so that the entire system and boiler may be drained.

4. RADIATION:

The radiation is to consist of six (38" -4 column) radiators placed as shown on apparatus floor, with a total of approximately 1040 square feet radiating surface;one (38" -2- column) radiator in office with approximately 40 square feet of radiating surface and one (38" -2-column) radiator of approximately 32 square feet radiating surface.

The radiation to be of pattern as selected by the Engineer in Charge.

5. COVERING:

Cover all pipe and fittings exposed in basement with an approved asbestos covering. The boiler is to be covered with 1-1/2" of asbestos bound on with wire netting and finished with canvas.

6. PAINTING:

Paint all radiators and exposed pipe, fittings and exposed parts of boilers with two coat work in colors as directed by the Engineer in Charge.

7. MATERIAL AND WORKMANSHIP:

All materials used in the construction of this heating system must be the best of their respective kinds, and all work to be done in a neat workmanlike manner, and to the satisfaction of the Enginner in Charge and the Chief Engineer of the Work.

8. GUARANTEE:

This Constructor must guarantee his work against any defects which may develop within one year after date of acceptance.

XXII. REMOVAL OF RUBBISH:

On completion of his work, the Constructor shall remove all his tools, scaffolding, debris, etc., from the work, and shall leave the premises perfectly clean as far as his work is concerned. He shall remove all dirt and rubbish at any other time without delay upon being requested to do so.

XXIII. GUARANTEE:

Unless otherwise specified, the Constructor shall guarantee to repair and make good at his own expense immediately upon demand, any imperfections in the work due to the use of inferior materials or to poor workmanship, which may appear within one (1) year from date of final acceptance of the work.

XXIV. EXTRAS:

No claim for extra compensation will be allowed, unless the work shall have been ordered in writing by the Engineer in Charge and the price agreed upon in advance and approved by the Chief Engineer of the Work.

XXV. INSPECTION:

All materials and workmanship of whatever kind or character shall be subject to the inspection and approval of both the Chief Engineer of the Work and the Engineer in Charge or their authorized representative, either in place or at the point of delivery or manufacture, and said representative shall be afforded all necessary facilities at all times to enable him to determine whether or not the materials and workmanship comply with this specification.

APPROVED June, 11th, 1909, as authorized by

BOARD OF SUPERVISING ENGINEERS
CHICAGO TRACTION

BY _____
Chairman and Chief Engineer

BY _____
Representing City of Chicago

BY _____
Representing Chicago Railways Company.

BOARD OF SUPERVISING ENGINEERS

CHICAGO TRACTION

ITEMIZATION OF ACCOUNTS
DIVISION - G

ITEM 1 - Temporary buildings for construction;
2 - Preparation of site;
3 - Wrecking buildings on site;
4 - Excavation, back filling, sheet piling, cofferdam work, and pumping necessary to allow of excavation being done;
5 - Filing for foundation, not including concrete.
6 - Foundation walls and footings, including forms;
7 - Plain concrete work (not included in Item #6) including forms;
8 - Reinforced concrete work (not included in Items #6 and #7), including forms;
9 - Brick work, masonary (not included in Item #6), including scaffolding, tile partitions, fireproofing of steel work brick stacks, cut stone, wall coping, terra cotta, including cleaning down walls, etc.
10 - Structural iron and steel work, which includes all iron and metal work, such as cast iron, columns for tracks, anchor bolts, stairs, steel lockers, ornamental iron work, steel fire doors, rolling steel doors, wire window guards, etc.
11 - Carpenter work, including all lumber, interior finish, mill work, trim, all stationary furniture and wooden fixtures in the building, but not including concrete forms and scaffolding in items 6, 7, 8 and 9.
12 - Roof covering.
13 - Sheet metal work, including skylights, fireproof windows and the glazing of the same; down spouts, gutters, flashing, etc.
14 - Lathing and plastering, including ornamental stucco work.
15 - Painting, whitewashing and glazing, not included im item #13.
16 - Plumbing, drainage and sewer systems, including the connections from the building to the street mains, gas piping, sprinkler system, fire protection apparatus, slate work, etc.
17 - Tile floors;
18 - Heating and ventilating systems, including piping, apparatus, boilers, stack and pumps when used for this purpose only.
19 - Lighting, including all electric wiring and conduit work, and all lighting and power switchboards.
20 - Paving in streets in front of and adjacent to the Company's building (not including the paving in tracks); sidewalks curbs and gutters, grading, sodding and final cleaning up of plant.
21 - Engineering and superintendence;
22 - Miscellaneous, including municipal permits and inspection charges, watchmen, construction tools, insurance, wages of clerks and timekeepers, light, water, power, etc.

Division G.

MONTHLY REPORTS OF MATERIAL AND LABOR REQUIRED FOR THE ERECTION OF BUILDING.

LOCATION.

GRAND AVENUE AND 40th, AVENUE.

ENGINEER'S MONTHLY ESTIMATE

May, 1909.

MATERIAL PLACED

Item 1, temporary office

2-2" x 12" x 32' second hand pine		128 B. F.
13-4" x 4" x12 ' " " "		208 B. F.
24-2" x 4" x 4' " " "		144 B. F.
4-2" x 4" x 125' " " "		33 B. F.
7-3" x 6" x 125' " " "		127 B. F.
28-1" x 6" x 28.5" " " "		395 B. F.
30-1" x 6" x 30' " " "		450 B. F.
" " " " 44' " " "		670 B. F.
" " " " 6' " " "		90 B. F.
Second hand doors, etc.		
2-1 3/8" x 31.5" x 6'7"		2 pcs.
1- 1 3/8" x 35.5" x 7'6"		1 pc.
Window sash 1 5/8" x 41" x 58.5"		8 "
contains 9-12" x 18" D.S. glass each.		
New lumber placed in benches		
2-2" x 12" x10' dressed pine		40 B. F.
3-2" x 12" x 15' dressed pine		90 B. F.
Total		130 B. F.
Add for waste		20 B. F.
		150 B. F.

Hardware	
Hasps	3 pcs.
Strap hinges 6"	1 pr.
T. bolts	1 pr.
Brass Yale padlock and chain	3 pcs.
Black enamel butts 4"	1 pr.
Brass novice lock	2 sets
Nails	300 #
Corrugated iron for roof,	
#20 galvanized second hand 30 pieces	200 #
Temporary closet	
Second hand pine	200 B. F.
Items 2 and 3, nothing	
Item 4, excavating	
Amount moved, building foundation	500 C. Y.
" " temporary closet	5 C. Y.
Total	505 C. Y.

Item 5 to 22, nothing

ENGINEER'S MONTHLY ESTIMATE.

May, 1909.

LABOR

Item	1	Laborers	68	hrs.
"	"	Carpenters	88	"
"	"	Carpenter Foreman	20	"
"	4	Union laborers	60	"
"	"	Union laborer foreman	60	"
"	"	Non-union laborers	1882	"
"	"	Teams	56	"
"	21	General foreman	60	"
"	22	Time keeper	60	"
"	22	Watchman	10	"
"	22	Water Boy	20	"
"	6	Carpenter foreman	4	"
"	6	Carpenter	8	"
"	20	Laborers	7	"

ENGINEER'S MONTHLY ESTIMATE.

June, 1909.

MATERIAL PLACED

Item #1

Temporary shed for cement.
10.5 ' x 12' x 9'
Lumber all second hand pine.

4-2" x 6" x12'		48 B. F.
8-4" x 4" x10.5'		95 B. F.
5-4" x 4" x 9'		60 B. F.
4-4" x 4" x 12'		65 B. F.
4-3" x 6" x 12'		63 B. F.
1-3" x 12" x 12'		36 B. F.
9-2" x 12" x 12'		216 B. F.
6" matched		500 B. F.
Add 10% for waste		117 B. F.
	Total	1200 B. F.

Hardware

Galvanized corrugated iron #20-2nd, hand	200 #
Tar felt	25 #
8" T bolts	1 pr.
6" hasp	1 pr.
Brass Yale padlock and chain	1 pr.
Nails	50 #

Temporary Office Building

32- 1" x 6" x 2.5" New pine, D 2 S		56 B. F.
6- 1" x 12" x 2'		15 B. F.
6- 2" x 12" x 1.25'		15 B. F.
Add 10% for waste	Total	17 B. F.
		103 B. F.
Second hand pine		
2-2" x 4" x 8' undressed		12 B. F.
12-2" x 4" x 3' undressed		24 B. F.
	Total	36 B. F.
14-1" x 6" x 8' D.1.S.		56 B. F.
Add 10% for waste		14 B. F.
	Total	70 B. F.

Hardware

8" T bolts	1 pr.
6" cast iron door pull	1 pc.
Brass drawer locks, two keys	4 pcs.
Nails	50 #

Chute for conveying concrete

4-2" x 12" x 16' D.1.S. pine		128 B. F.
1-2" x 12 " x 12' D.1.S. pine		24 B. F.
Add 10% for waste		18 B. F.
	Total	170 B. F.

ENGINEER'S MONTHLY ESTIMATE.

June, 1909.

MATERIAL PLACED

Item #1 continued

Mixer platform, lumber undressed 2nd, hand	2880 B. F.
Nails	100 #
Connecting mixer for power	
#6 insulated copper wire	200 ft.
Green glass insulators	2 pcs.
Glass insulator holders	2 pcs.
Wood strain insulators	1 pc.
Item #2 and #3 nothing.	
Item #4 excavating foundation	960 C.Y.
Item #5 nothing	
Item #6 plain concrete	
Wall foundations (forms)	
Lumber, new pine D.1.S.	8730 B. F.
Lumber, second hand D.1.S.	18810 B. F.
Hardware used on forms	
Nails	3000 #
Wire #11, 1200'	4000 #
Lumber used on runway 2nd, hand pine	4350 B. F.
Nails	100 #
355 C.Y. of 1-3-6- mix.	
Portland cement	436 bbls.
Torpedo sand	165 C.Y.
Crush stone	327 C.Y.
Soft soap	5 bbls.
Powdered alum	4 bbls.
Rotary foundation wall forms	
Lumber, second hand pine D.1.S.	15000 B. F.
Concrete placed 36.5 C.Y. of 1-3-6 mix	
Portland cement	4.1 bbls.
Torpedo sand	.17 C.Y.
Crushed stone	34 C.Y.
Soft soap	.5 bbls.
Powdered alum	.5 "
Items #7, 8, and #9 nothing	
Item #10 , steel and iron	
2-3" Std. Z bars 92.3' @ 8.4#	776 #
60 iron bends @ 1.5	90 #
10- ½" x 6" x 24" plates	204 #
20-1½" x 4.5' column bolts	540 #
Total	1610 #
Items #11 to #18 nothing	
Item #18 heating	
1-C.I. Soot door	100 #

Items #19 to #22 nothing

ENGINEER'S MONTHLY ESTIMATE

June, 1909.

LABOR

Item #1	
Carpenters	100 hrs.
Laborers , union	64 hrs.
Laborers, non-union	8 hrs.
Item #4	
Labor foreman, non-union	107 hrs.
Laborers, non-union	3627 hrs.
Teams	215 hrs.
Labor foreman, union	1 hr.
Laborers, union	77 hrs.
Item #6	
Carpenter helpers	104 hrs.
Inspector	74 hrs.
Carpenter foreman	112 hrs.
Carpenter	1420 hrs.
Laborers	2349 hrs.
Laborers, non-union	10 hrs.
Labor foreman, union	86 hrs.
Item #9	
Carpenter	24 hrs.
Carpenter helper	24 hrs.
Item #20	
Labor foreman	8 hrs.
Laborers	176 hrs.
Carpenter	4 hrs.
Item #21	
General foreman	204 hrs.
Item #22	
Time keeper	204 hrs.
Watchman	56 hrs.
Waterboy	24 hrs.
Electricians	4 hrs.
Carpenter foreman	4 hrs.
Carpenter	8 hrs.
Laborers, union	4 hrs.
Laborers, non-union	30 hrs.

ENGINEER'S MONTHLY ESTIMATE.

July, 1909.

MATERIAL PLACED

Item #1	
Temporary closet second hand pine, D.1.S.	570 B. F.
Hardware	
Tar paper	30 #
Nails	10 #
Galvanized corrugated iron 2nd, hand	200 #
Door knobs	1 pr.
Brass drawer lock	1 pc.
Item #2 to #4 nothing	
Item #4 excavating	
For sump	8 C.Y.
Back filling	100 C. Y.
Item #5 nothing	
Item #6 Plain Concrete	
15 C.Y. in footing etc.	
Cement	19 bbls.
Torpedo sand	10 C.Y.
Crush stone	15 C.Y.
Powdered alum	75 #
Soft soap	75 #
182 C.Y. in Rotary walls.	
Portland Cement	224 bbls.
Torpedo sand	118 C.Y.
Crushed stone	175 C. Y.
Powdered alum	160 #
Soft soap	150 #
Lumber, pine D.1.S.	1000 B. F.
Wire #1	50 #
Nails	400 #
Steel 15" I beam 122# 42 pieces	5124 #
Item #7 Plain Concrete	
9 C.Y. for negative tile ducts	
Portland cement	11 bbls.
Torpedo sand	6 C.Y.
Crush stone	9 C. Y.
Cable duct conduit	500 ft.
53.5 C.Y. in basement floor	
Portland cement	66 bbls.
Crush stone	51 C.Y.
Torpedo sand	35 C.Y.
Powdered alum	245 #
Soft soap	100 #
150' #11 wire @$3.88	6 #
Pine Lumber for forms	262 B. F.
Nails	10 #

ENGINEER'S MONTHLY ESTIMATE.

July, 1909.

MATERIAL PLACED

Item #7 (continued)	
5 C.Y. in concrete water table	
Portland Cement	6 bbls.
Torpedo Sand	4 C.Y.
Crushed stone	5 C.Y.
Powdered alum	30 lbs.
Soft Soap	20 "
Item #8	
Reinforced concrete	
Form Lumber	170 B. F.
Nails	10 lbs.
Coal Bunker Desk 23' old 4" car rails	330 "
3/8" twisted bar	500 "
C.I. Hatch covers and frames	150 "
Portland Cement	4 bbls.
Torpedo Sand	2 C.Y.
Crushed Stone	3 C.Y.
Item #9,Cut Stone water table	
Note: This stone is covered by contract	103.4 C.F.
Brick Laying	
Common Brick in basement wall	7000 Pcs.
Lime	7 bbls.
Cement	1 bbl.
Bank Sand	3 C.Y.
Item #10	
Steel work	
10 Steel Columns @ 2T.	40,000 lbs.
5 Trusses @ 2T.	20,000 "
I beams in floor framing, etc.	47,000 "
Note: This steel is covered Total	107,000 "
in G. W. Jackson's contract.	
Cast Iron columns 23 placed @296 lbs.	6810 "
" " washers 25 " @ 65 "	1625 "
Total	8435 "
Item #11 Mill work	
Floor door jambs 1" x 4" x 7'	1 pc.
B " " 1" x3.5' x 7'2"	1 "
A " " 8" x 3' x 7'	2 "
B " " 8" x 3' x 7'1"	2 "
Note: Above Mill work is covered in contract.	
Item #12 Nothing	
Item #13 Sheet Metal Work	
Metallic window frames in basement are in place	10 pcs.
Note: Contract with Mc Farlane Co., covers this work	

ENGINEER'S MONTHLY ESTIMATE.

July, 1909.

MATERIAL PLACED

Item #14 nothing	
Item #16	
Plumbing and Sewerage	
4" Form tile placed under basement floor	120 ft.
Item #19 Lighting	
3/4" galvanized conduit	170 ft.
1" " "	20 "
Iron Junction Boxes, small	10 lbs.

ENGINEER'S MONTHLY ESTIMATE.

July, 1909.

LABOR

Item #1	
Labor foreman	9 hrs.
Laborers	88 hrs.
Carpenter foreman	36 hrs.
Carpenters	93 hrs.
Carpenter helpers	104 hrs.
Item #4	
Labor foreman	20 hrs.
Laborers	446 hrs.
Teams	48 hrs.
Item #6	
Carpenter foreman	80 hrs.
Carpenters	609 hrs.
Carpenter helpers	320 hrs.
Laborers	1604 hrs.
Labor foreman	49 hrs.
Operating engineer	28 hrs.
Concrete finisher	68 hrs.
" " Helpers	60 hrs.
Item #7	
Carpenter foreman	13 hrs.
Carpenters	59 hrs.
Operating engineer	14 hrs.
Laborer foreman	131 hrs.
Laborers	962 hrs.
Concrete finishers	56 hrs.
" " helpers	55 hrs.
Work cars	20 hrs.
Item #8	
Carpenter foreman	47 hrs.
Carpenters	315 hrs.
Carpenter helpers	103 hrs.
Laborers	44 hrs.
Labor foreman	3 hrs.
Concrete finisher	2 hrs.
" " helpers	4 hrs.
Item #9 M. S. O'Day	
Brick layer foreman	44 hrs.
Brick layers	88 hrs.
Helpers	127 hrs.
Item #10 Mc Farland	
Sheet metal workers	5 hrs.
Helpers	3 hrs.

ENGINEER'S MONTHLY ESTIMATE.

July,. 1909.

LABOR

Item #10	
Carpenter foreman	1 hr.
Carpenters	14 hrs.
Helpers	4 hrs.
Laborers	20 hrs.
Steel erector foreman	136 hrs.
Steel erectors	849 hrs.
Item #11	
Carpenters	12 hrs.
Helpers	8 hrs.
Item #16	
Labor foreman	2 hrs.
Laborers	28 hrs.
Concrete finishers	4 hrs.
Helpers	4 hrs.
Item #17	
Laborers	16 hrs.
Item #18	
Laborers	4 hrs.
Item #19	
Electrician foreman	52 hrs.
Electrcians	90 hrs.
Helpers	4 hrs.
Item #21	
General foreman	196 hrs.
Item #22	
Time keeper	196 hrs.
Watchman	60 hrs.
Waterboy	25 hrs.

Foreman carpenter	15 hrs.
Carpenter	40 hrs.
Helper	40 hrs.
Labor foreman	11 hrs.
Laborers	62 hrs.

ENGINEER'S MONTHLY ESTIMATE

August, 1909.

MATERIAL PLACED

Item #1 to #6 nothing	
Item #7 plain concrete	
20 C.Y. 1-3 grout in windows	
Cement	8 bbls.
Torpedo sand	20 C. Y.
Item #8	
Reinforced concrete	
70 C.Y. 1-2-4 in main floor	
Portland cement	160 bbls.
Torpedo sand	30 C.Y.
Crush stone ½"	60 C. Y.
Twisted steel bars ½" 6674' @ .85#	5673 lbs.
Lumber	2000 B. F.
Nails	100 lbs.
Wire mesh ¼"	100 "
Item #9	
Brick work building walls	
Pressed brick 960 C.F.	16,320 pcs.
Common brick 3,620 C.F.	228,800 "
Lime	280 bbls.
Bank Sand	210 C.Y.
Portland Cement	88 bbls.
Mortar color 10 bbls.	3300 lbs.
White sand	70 bbls.
Brick work, basement walls	
Common brick 3500 pcs.	3500 pcs.
Lime	3.5 bbls.
Bank Sand	3 C.Y.
Portland Cement	1 bbl.
Cut stone Window sills, etc.	400 C.F.
Note: This material is covered under contract with Edwards & Ward.	
Percent of contract placed 90%.	
C.I. Item #10 Steel and Iron	
Misc. pcs. in place	22,000 lbs.
Note: 90% of G. W. Jackson's contract placed.	
C.I. caps 5" @ 296# 4 pcs.	1184 lbs.
C.I. washers 65# 4 pcs.	260 "
C.I. Floor plates 500# 5 pcs.	2500 "
C.I. Floor plates drilled 200# 5 pcs.	1000 "
Total	4944 "
Item #11 Mill Work	
North door frame 8" x 3' x7'1"	1 pc.
Note: This mill work is covered under separate contract with Van Platen & Dick, 80% placed.	

ENGINEER'S MONTHLY ESTIMATE.

August, 1909.

MATERIAL PLACED

Item #12 nothing	
Item #13 SheetMetal work	
Fire-proof window frames	
Main floor 8' 1" x 15'1"	9 pcs.
" " 3' 8" x 7'	1 "
8' 1" x 6'6"	9 pcs.
Note: Covered under contract with J. E. Mc Farlein, 50% placed.	
Item #14 to #18 nothing	
Item #18 Heating	
Stack carried up with building walls	
Fire brick placed (queen run)	600 pcs.
" clay	½ bbl.
Item #19 Lighting	
Galvanized conduit ½"	70 ft.
Junction Boxes 2½" x 3"	10 pcs.
Galvanized conduit ¾"	150 ft.
Arc Light plates and bolts	600 lbs.
Item #20 to #22 nothing	

ENGINEER'S MONTHLY ESTIMATE.

August, 1909.

LABOR

Item #1	
Labor foreman	4 hrs.
Labor	24 "
Carpenter foreman	6 "
Carpenters	60 "
Helpers	16 "
Item #6	
Labor foreman	2 hrs.
Labor	24 "
Item #8	
Carpenter foreman	56 "
Carpenters	512 "
Helpers	160 "
Labor foreman	30 "
Labor	608 "
Cement finishers	9 "
Helpers	8 "
Labor foreman	8 "
Labor	108 "
Item #9	
Labor foreman	30 "
Labor	496 "
Carpenter foreman	125 "
Carpenters	759 "
Helpers	713 "
Brick Layer foreman	224 "
Brick layers	8 "
Stone cutters	12 "
Steel erecters	104 "
" erecter foreman	12 "
Brick layer foreman	170 "
Brick layers	2854 "
" layer helpers	2670 "
Item #10	
Labor	8 "
Steel ercter foreman	52 "
Steel erecters	308 "
Carpenters	8 "
Item #11	
Carpenter foreman	4 "
Carpenters	32 "
Item #12 Standard Roofing Co.,	
Roofer's foreman	4 "
Roofers	70 "
Teams	10 "
Item #13	
J. C. Mc Farlain	
Sheet metal workers	33½ "
Helpers	9 "

ENGINEER'S MONTHLY ESTIMATE.

August, 1909.

LABOR

Item #13 (continued)	
Carpenter foreman	1 hr.
Carpenters	16 hrs.
Helpers	8 "
Labor foreman	5 "
Labor	66 "
Item #16	
Labor foreman	6 "
Labor	56 "
T. Conlan	
Plumber	4 "
Item #18	
Brick Layer	24 "
Helper	12 "
Item #19	
Electrician foreman	29 "
Electricians	178 "
Item #20	
Labor foreman	106 "
Labor	1392 "
Carpenters	16 "
Carpenter foreman	4 "
Item #21	
General foreman	60 "
Item #22	
Time keeper	212 "
Watchman	77 "
Water boy	368 "

ENGINEER'S MONTHLY ESTIMATE.

September, 1909.

MATERIAL PLACED

Items #1 to #7 nothing	
Item #7, Plain concrete	
Misc. repairs on building	
Portland cement	2 bbls.
Torpedo Sand	1 C.Y.
Grouting metal window frames	
Portland Cement	2 bbls.
Torpedo Sand	1 C.Y.
Roof Saddle, 10 C.Y. 1-3-5-Mix	
Portland Cement	17 bbls.
Torpedo Sand	5 C.Y.
Cinders	15 C.Y.
Item #8 Reinforced Concrete	
Battery room shelves 3¼ C.Y. 1-3-5-Mix	
Portland Cement	5.5 bbls.
Torpedo Sand	3 C.Y.
Crushed Stone ½"	1 C. Y.
Twisted Steel Bars ½"	100 lbs.
Repairs to main floor	
Portland Cement	1.5 bbls.
Torpedo Sand	1 C.Y.
Main floor, N.and S. 3 C.Y. 1-3-5-Mix	
Portland Cement	4.5 bbls.
Torpedo Sand	2 C.Y.
Crushed stone	3 C.Y.
Twisted Steel Bars ½"	200 lbs.
Item #9 Brick Work, etc.	
In building out-side walls	
Common brick	40 M.
Press Brick	15 M.
Enameled brick	15 M.
Lime	70 bags
Cement	48 "
Bank Sand	60 C.Y.
White Sand	4 bbls.
Mortar color	3 bbls.
Wire Mesh	50 lbs.
Cut Stone Setting	
Amount placed	31 C.Y.
Lime	3 bbls.
Portland Cement	3 "

Note: This stone is covered under contract with Edwards & Ward. This completes this contract.

ENGINEER'S MONTHLY ESTIMATE.

September, 1909.

MATERIAL PLACED

Item #9 (continued)

Terra Cotta as furnished under contract by The Chicago Terra Cotta Company is all in place.	
Portland Cement (by C. Ry's Co.,)	3 bbls.
Lime	3 "
Wire, etc.	100 lbs.
Wall Coping, vitrified tile 12" x 26" (by C. Ry's Co.,)	68 pcs.
Book Tile, Roof 3" x 12" x 1¼" (by C. Ry's Co.,)	2370 pcs.
Lime	2 bbls.
Portland Cement	2 "
Bank Sand	1 C.Y.
Item #10 Steel and Iron	
Placed in Structural Steel Frame	2 Tons.
Note: This material is covered under contract with Geo. W. Jackson and this completes the contract.	
Item #11 Mill Work, nothing.	
Item #12 Roof Covering	
5 ply gravel and felt	3533 Sq. Ft.
Note: This roof is complete.	
Item #13 Sheet Metal Work.	
Copper Conductor Head	4 pcs.
4" C.I. Drain Spouts	30 ft.
4" W.I. " "	60 "
Note: Above material is covered under contract with T. Conlin.	
Skylight as covered under contract with Knisley Bros. in place.	
Copper flashing an extra with Knisley Bros., is all in place.	
16 sheets 30" x 96" 25 gauge copper	320 sq. ft.
Metallic window sash in main story and covered under contract with The Mc Farlain Company has progressed about 10%,60% is now in place.	
Item #14 Plastering Basement Walls.	
Portland Cement	12.5 bbls.
Bank Sand	6 C.Y.
Item #15 Painting	
Power House Ceiling 3600 Sq. Ft.	
Builder's gray	30 Gal.
Oxoline	10 "
Boiled Oil	10 "

ENGINEER'S MONTHLY ESTIMATE.

September, 1909.

MATERIAL PLACED

Item #15 (continued)

Wood Doors, sash and frames	
Varnish	1 gal.
Wood Filler	1 "
#00 Sand Paper	24 sheets.
Builder's gray	.5 gal.

Item #16 Plumbing

Closet, roughed in .

Note: This work is covered under contract with T. Conlin. About fifty percent of plumbing is completed. All sewer work, including catch basin as stipulated in contract with T. Conlin is complete.

Item #17 and #18 nothing

Item #19 Lighting

#14 Single Stranded Copper Wire	4585 ft.
# 6 " " " "	600 "
5 lt. Harter Cluster	17 pcs.
2 lt. Harter Cluster	3 pcs.
4 lt. " "	1 pc.
Wall Sockets	3 pcs.
Spec. $2\frac{3}{4}$ Junction Box	12 "
16 Candle Power Incandescent Lamps	100 "
$\frac{1}{2}$" Galvanized Conduit	150 ft.
Switch Board	
1-1" x 16" x 28" Slate Slat	3 Sq. Ft.
2-3/16" x 1" x 20" Flat Bar Iron	2 lbs.
4-$\frac{3}{4}$" x 3" Lag Screws	4 pcs.
4-$\frac{1}{4}$" x 2" Bolts	4 "
C.I. Expansion Bolt Blocks	4 "

Item #20 to#32 nothing

ENGINEER'S MONTHLY ESTIMATE.

September, 1909.

LABOR

Item #8		
Labor Foreman	16	hrs.
Labor	218	"
Carpenter Foreman	21	"
Carpenters	160	"
Construction Foreman	56	"
Helpers	36	"
Carpenter Helpers	36	"
Masons	4	"
Helpers	4	"
Item #7		
Carpenter Foreman	8	"
Carpenters	16	"
Helpers	24	"
Labor Foreman	11	"
Labor	129	"
Item #9		
Carpenter Foreman	75	"
Carpenters	272	"
Helpers	508	"
Brick Layer Foreman	44	"
Labor Foreman	29	"
Labor	470	"
Steel Erecter Foreman	6	"
Steel Erecters	26	"
M. S. O'Day		
Brick Layer Foreman	134	"
Brick Layers	1673	"
Brick Layer Helpers	1604	"
Mason Foreman	1	"
Mason	16	"
Helpers	16	"
Item #10		
Steel Erecter Foreman	29	"
Steel Erecters	444	"
Labor Foreman	6	"
Machinists	24	"
Carpenters	2	"
Item #11		
Brick Layers	28	"
Helpers	16	"
Item #13		
Labor Foreman	4	"
Labor	22	"
Carpenters	8	"
Helpers	8	"

ENGINEER'S MONTHLY ESTIMATE.

September, 1909.

LABOR

Item #13 (continued)		
Knisley Bros.,		
Teams	8	hrs.
Sheet Metal Workers	64	"
Helpers	64	"
McFarlain		
Sheet Metal Workers	32	"
Helpers	32	"
Item #14		
Cement Finishers	172	"
Helpers	144	"
Labor	196	"
Item #15		
Painters	278	"
Item #16		
T. Conlin		
Pipe Layers	16	"
Helpers	40	"
Plumber Foreman	4	"
Sewer Men	48	"
Helpers	132	"
Plumbers	138	"
Item #18		
Labor Foreman	4	"
Labor	36	"
Steam Fitters	20	"
Helpers	20	"
Item #19		
Electrician Foreman	71	"
Electricians	380	"
Item #20		
Labor Foreman	117	"
Labor	1145	"
Carpenter Foreman	8	"
Carpenters	60	"
Helpers	20	"
Work Cars	34	"
Item #21		
Superintendent	196	"
Item #22		
Steam Fitters	4	"
Helpers	4	"
Electricians	8	"
Time Keepers	200	"
Watchman	90	"
Water Boy	368	"
Mechanics	24	"

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

MATERIAL PLACED

Item #1 to #7 nothing	
Item #7, Plain Concrete	
Misc. Repairs	
Portland Cement	5 bbls.
Torpedo Sand	5 C.Y.
Item #8 Reinforced Concrete	
North Stairway 2.5 C.Y. 1-3-6Mix	
Portland Cement	6 bbls.
Torpedo Sand	3 C.Y.
Crush Stone	5 C.Y.
Reinforcing Bar, twisted ½" x 54'	46 lbs.
" " " ⅝" x 6'	12 "
South Stairway 2.5 C.Y. 1-3-6-Mix	
Portland Cement	6 bbls.
Torpedo Sand	3 C.Y.
Crush Stone 1"	4 C.Y.
Reinforcing bar, twisted ½" x 50'	43 lbs.
" " " ⅝" x 12'	17 "
Item #9 Brick Work	
Bricking up foundation pockets	
Common Brick	250 pcs.
Lime	¼ bbl.
Cement	¼ "
Closet in office walls	
Common Brick	2500 pcs.
Eneameled Brick,Stretchers white & green	3000 "
Enameled Brick Quoins white & green	100 "
Book Tile 3" x 12" x 17.5 "	150 "
Lime	5 bbls.
Cement	5 "
Bank Sand	3 C.Y.
Store-room partition	
Common Brick	1000 pcs.
Lime	1 bbl.
Cement	1 "
Bank Sand	1 C.Y.
Book Tile 3" x 12" x17.5"	5 pcs.
Building Walls	
Enamel Brick Quoins	1100 pcs.
" " Stretchers	49600 "
White Sand	3 bbls.

ENGINEER'S MOTNHLY ESTIMATE

OCtober, 1909.

MATERIAL PLACED

Item #10 Steel Framing.	
North Stair Framing	
4 Std. 10" Channel 5' long @15#	300#
2 " 6" I's 6.5' @12.25#	160 #
2 " 6" " 4.9' @12.25#	120 #
20-3" x 3" x 9" angles @ 4.9 #	74 #
2- 2" x 2" x 4.9' @2.5 #	25 #
6- 2" x 2" x 5' @ 2.5#	40 #
28-$\frac{3}{4}$" x 2" bolts @ .375#	11 #
Framing over office and closet for roof	
16 Std. 2$\frac{1}{2}$" T. Iron 10.25' long @5.5#	902 #
2 Std. 4" angles 12.25' long @8#	196 #
Lintels over office and closet doors and windows,. Note: Material furnished by contract by G. W. Jackson and is now being placed.	
2-5/16" x 4" x 4" angles @ 8.2#	66 #
2-5/16" x 4" x 3" " @ 8.2#	50 #
3-5/16" x 7" x 3.5' plates @ 2.19#	15 #
3-4" Std. 5$\frac{1}{2}$' channels @ 5.25#	55 #
Item #11 Mill work	
Material furnished under contract with Van Platen & Dick.	
1-3' x 2" x 7' Oak Door Jambs	
1-2' x 8" x 7' Oak Door Jambs	
3-3' x 6' x 2" Oak Window Frames	
1-3' x 8" x 7' Panel Glass Door South	
1-3' 2" x 7' Panel Door North	
Item #12 nothing	
Item #13 Sheet Metal Work	
1-12' x 12' Roll Steel Doors	144 Sq. Ft.
Second Hand Material by Railways' Co., Metal Window Sash and Glazing on main and top story windows as covered under contract with J. C. Mc Farlain & Co., entire work now completed.	100 %
Window opening devices are entirely in place. This device was placed by contract with Kinsely Bros.	100 %
Item #14 Plastering	
On basement walls	
Portland Cement	10 bbls.
Torpedo Sand	3 "
Item #15 Painting and Whitewashing	
Station Ceiling fourth coat	
Builder's Gray Paint	7 Gals.
Window Sash and Steel Work	
Builder's Gray Paint	5 Gals.

ENGINEER'S MONTHLY ESTIMATE

October, 1909.

MATERIAL PLACED

Item #15 (continued)	
Trolley Pole black	10 Gals.
Cold Water Paint	200 #
Item #16 Plumbing	
Placing Water Pipe For Toilet Room Material and Labor furnished under contract with T. Conlin, plumbing and heating company. About 10% of the work has been done this month,. Work completed to date,	60 %
Item #17 Nothing	
Item #18 Heating	
Bricking up Kewanee Boiler	
Common Brick	2000 pcs.
Cement	1 bbl.
Lime	5 "
Fire Brick Queen runs	100 pcs.
Bank Sand	2 C.Y.
Steam Coils and Piping	
Rad. 8 sec. 2 pipe, 38" high for toilet room	1 pc.
" 10 " " " " " " office	1 "
" 15 " 3 " " " " Main floor	1 "
" 19 " 3 " " " " " "	1 "
" 24 " " " " " " " "	3 "
" valves ½" Jenkins	8 "
" " 1" "	2 "
" " 1¼ " "	1 "
" " 1½" "	4 "
" Air Valves #6 Acme	9 "
Angle Valve, com. 1"	1 "
Gate Valve 2"	1 "
Check valve 2"	1 "
" " 1"	1 "
Gate Valve 1"	3 "
" " ½"	1 "
Plugs 1"	1 "
Globe Valve 1"	2 "
Gate Valves 3"	1 "
Mal. Iron Pipe 2½"	157.7 ft.
" " " 2"	255.75 "
" " " ½"	80 "
" " " 3/8"	64 "
" " " ¼"	10 "
½" C.I. Ells	30 pcs.
½" 45 deg. Ells	12 pcs.
1" " " T's	2 "
Bushing 1½" x 1¼"	6 "
Bushing ½" x 3/8"	4 "
Reducing Ells 4" x 3" C.I.	1 pc.

ENGINEER'S MONTHLY ESTIMATE

October, 1909.

MATERIAL PLACED

Item #18(continued)	
Reducing T 3" x 1" x 3"	1 pc.
Reducing T 3" x 2½" x 1½"	4 "
Boiler Breaching 1/16" sheet iron	500 lbs.
Pipe Hangers 3"	4 pcs.
" " 2"	12 "
Item #19 Lighting	
Black Enamel Conduit ¾"	20 ft.
" " " ½"	40 "
2¾" C.I. Junction Boxes	6 pcs.
Arc Lamp Hooks in Wall	10 pcs.

ENGINEER'S MONTHLY ESTIMATE

October, 1909.

LABOR

Item #3	
Carpenter	4 hrs.
Item #7	
Labor	48 "
Cement Finishers	32 "
Helper	32 "
Item #8	
Cement Finsihers	20 "
Helpers	20 "
Labor	96 "
Carpenters	64 "
Helpers	44 "
Labor Foreman	8 "
Item #9	
Labor Foreman	27 "
Labor	284 "
Cement Finishers	24 "
Helpers	16 "
Carpenters	20 "
Brick Layer Foreman	94 "
Brick Layers	520 "
Helpers	416 "
Apprentice	144 "
Brick Washer	64 "
Item #10	
Carpenter	16 "
Helper	8 "
Mechanics	140 "
Helpers	140 "
Steel Erecters	4 "
Item #11	
Carpenters	68 "
Helpers	4 "
Item #13	
Mc Farlain Company	
Sheet Metal Workers	156 "
Helpers	156 "
Sheet Metal Foreman	12 "
Knisely Bros.	
Sheet Metal Workers	128 "
Helpers	128 "
Item #14	
Cement Finishers	24 "
Helpers	24 "
Labor	16 "
Item #15	
Painters	524 "
Item #16	
Labor	8 "

ENGINEER'S MONTHLY ESTIMATE

October, 1909.

LABOR

Item #16	
T. Conlin	
Plumbers	25 hrs.
Item #18	
Steam Fitters	152 "
Helpers	152 "
Boiler Makers	12 "
M. S. O'Day	
Brick Layer Foreman	8 "
Brick Layers	60 "
Helpers	38 "
Item #19	
Electricians	72 "
Item #20	
Labor Foreman	153 "
Labor	1317 "
Carpenters	20 "
Work Cars	24 "
Item #21	
Superintendent	200 "
Item #22	
Time Keeper	200 "
Watchman	130 "
Water Boy	244 "
Steam Fitters	12 "
Helpers	12 "

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

MATERIAL PLACED

Item #1 to #8 nothing.	
Item #8 Reinforced Concrete.	
Straightening Main Floor Levels.	
Portland Cement	12.5 bbls.
Torpedo Sand	3 C.Y.
Item #9 Brick Laying	
Closing Foundation Wall Pockets	
Common Brick	250 pcs.
Cement	¼ bbl.
Lime	¼ "
Bank Sand	¼ C.Y.
Tile Setting	
Closet Partitions	
Book Tile 3" x 12" x 17.5"	50 pcs.
Portland Cement	½ bbl.
Lime	½ "
Bank Sand	½ C.Y.
Item #10 Structural Steel	
Steel Supports for Canopy	
4-3/8" x 3" x 3" x 33' angles	950 lbs.
10-5/16" x 3" x 16" plates @5#	67 "
4-¼" x 3" x12" plates @.75#	3 "
46-7/16" x 1" bolts	4 "
20-7/16" x 2" "	3 "
American Mason Safety Treads on stair steps.	
4" x 52"	16 pcs.
Item #11 Mill Work	
3' x 2" x 7' Oak Doors in air lock	2 pcs.
3' x 2" x 7' " Door in office with glass panel	1 pc.
2' 8" x 7' Oak Door in closet	1 "
2'10" x 7' Boiler Room and Battery Room doors	2 "
2' 6" x 5' Lower Door in Closet	1 "
3' x 7' Oak Door Jamb in Closet	1 "
5" x 7/8" " " Casing	68 ft.
6" x 7/8" Oak Base-board	71 "
Note: All items in above list of Mill Work are covered under contract with Van Platen & Dick Company, excepting the oak Base-board.	
Store-room shelving	
9-2" x 12" x 15.5' sq. 2S New Pine	278 B.F.
5-2" x 12" x 6.6 ft." " " "	67 B.F.
5-2" x 12" x 3' " " " "	30 B.F.
1-1' x 6" x 15.5' " " " "	8 B.F.
Add 10% for waste	36 B.F.

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

MATERIAL PLACED

Item #11 (continued)	
Hard-ware used on doors and Mill work	
5" black enamel hinges	12 pr.
Door Locks Yale & Town Mnfg. #432 with handle	4 sets
Door Locks, Yale & Town Mnfg. with knobs	4 "
½" x ½" wood screws	1 gross
Finishing Nails 10d	10 lbs.
North Stair Tread to basement	
4-10" x 1¾" x 45" S4S New Oak	25 B.F.
4-10" x 1¾" x 4' " " "	27 B.F.
32-½" x 2½" Bolts	8 lbs.
North roll steel door frames	
2-2½" x 5" x 12' Georgia Pine	25 B.F.
12-¼" x 8" Lag Screws	2 lbs.
4-½" x 4" " "	1 lb.
Item #12 Sheet Metal Work	
Canopy 3-9' x 16' #22 Corrugated Galvanized Iron and Gutter	
24-25.5" x 9¼' #22 Cor. Galv. Iron	672 lbs.
6-14" x 9' Flat Sheet #22 Galv. Iron	84 "
1-10" x 150' Flat Sheet Galv. Iron	194 "
Rivets	5 "
Soulder	1 "
Item #13 Nothing	
Item #14 Lath and Plastering office and closet walls.	
#24 Painted Metal Lath, 18" x 8'	900 Sq. Ft.
¾" Crimped Furring Strips	500 ft.
½" Galv. Staples	10 lbs.
Sand Float Finish Stucco	2.2 bags
Regular Browning Sanded Plaster	65 "
Note:The last two items in above list were finished by O'Brien & Co., who did this 122 sq. ft. of two coat work plastering under contract, balance of work finished by Railway Company.	
Plastering basement walls	
Portland Cement	5¼ bbls.
Bank Sand	2 C.Y.
Item #15 Painting and Whitewashing	
Interior Finish	
Al Varnish, white color	3 Gals.
Filler	2 "
Benzine	1 "
Turpentine	2 "
#0 Sand Paper	12 sheets
Japan Dried	1 Gal.
Shellac	1 "
Builder's Gray Paint	2 "

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

MATERIAL PLACED

Item #15(continued)	
Painting outer wall, two coats of	
Venetian Red	500 lbs.
White Lead	90 "
Boiled Linseed Oil	35 Gal.
Builder's Gray Paint	5 "
Painting Structural Steel	
Builder's Gray	2 Gals.
Painting Radiators	
Builder's Gray Paint	½ Gal.
Painting Roll Steel Doors two coats	
Builder's Gray	½ "
Ivory Drop Black	1 Gal.
Painting Canopy	
Builder's Gray	5 "
White Lead	10 lbs.
Boiled Linseed Oil	1 Gal.
Japan Dried	1 "
Painting Window Sash and opening devices	
Builder's Gray Paint	10 Gal.
Whitewashing 120 sq. ft. of basement walls	
Cold Water Paint	200 lbs.
Item #16 Plumbing	
Patching opening in foundation for down spouts.	
Portland Cement	1 bbl.
Torpedo Sand	½ C.Y.
Note: Plumbing fixtures furnished and placed by contract with T.Conlin is now complete.	
Setting Sump Pump	
Portland Cement	2 bbls.
Torpedo Sand	½ C.Y.
Pine Lumber S4S	100 B.F.
Sheet Tin	5 lbs.
2-½" x 3¼" x 5" x 4' I-beam	78 "
4-½" x 3" bolts	1 lb.
Roth Bros., Company Sump Pump Motor	
Horse Power 1½,amp. 2.75,voltage 500, R.P.M.900,	1 pc.
Morris Machine Works, Centrifugal Pump Comp.	1 pc.
Item #17	
Tile Floors, Asbestos Compostion	
In office 120 sq. ft. was placed	
Composition Asbestos	4 bags.
Acid used with Asbestos	6.7 Gals.
Note: This work is covered under contract with Asbestos Composition Flooring Company.	

ENGINEER'S MONTHLY ESTIMATE

November, 1909.

MATERIAL PLACED

Item #18 Heating	
Steam Fittings	
½" C.I. Lock Nut Unions	2 prs.
¾" Tubing	1 pc.
1" C.I Lock Nut Union	1 pc.
Item #19Lighting	
½" Galvanized Conduit	20 ft.
#10 Insulated Wire	50 ft.
C.I. Junction Boxes	2 pcs.
Item #20 to #22 inclusive nothing	
Item #10 Steel & Iron	
2 C.I. 1" x 20" x 20" covers	50 lbs.
2-¾" x 2½" x 80" Flat Bars	26 "

To construct 278' of 6' concrete walk,
5" thick.
Total 1404.5 sq. ft. placed
Total 17.33 C.Y. in body
Total 4.33 C. Y. in top
Mix is 1-2½-5 body
Mix is 1-1½ Top

Portland Cement	32 bbls.
Torpedo Sand	18 C.Y.
Crushed Stone	16 C.Y.

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

LABOR

Item #1	
Labor Foreman	8 hrs.
Carpenter	12 "
Helpers	24 "
Item #7	
Carpenter	60 "
Helpers	20 "
Labor	48 "
Cement Finisher	28 "
Helpers	28 "
Item #8	
Cement Finisher	34 "
Helpers	54 "
Carpenter	8 "
Cement Finisher	16 "
Helper	8 "
Labor	46 "
Item #9	
Cement Finisher	4 "
Helpers	4 "
M.S. O'Day	
Brick Layer Foreman	12 "
" "	16 "
Helper	24 "
Apprentice	16 "
Item #6	
Labor	8 "
Item #10	
Steel Erecter Foreman	18 "
" "	84 "
Mechanics	16 "
Item #11	
Carpneter	204 "
Helpers	48 "
Item #13	
Farwell Cornice Co.,	
Sheet Metal Workers	8 "
Helpers	8 "
Knisely Bros.,	
Sheet Metal Workers	4 "
Item #14	
Cement Finishers	36 "
Helpers	56 "
Labor	16 "
O'Neill	
Lathers	20 "
O'Brien	
Plasterers	32 "
Helpers	16 "

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

LABOR

Item #15	
Painters	410 hrs.
Item #16	
Machinists	8 "
Helpers	16 "
William Graham Co.,	
Plumbers	12 "
Item #17	
Asbestos Composition Flooring Co.,	
Cement Finishers	8 "
Helpers	8 "
Item #19	
Electricians	12 "
Item #20	
Labor Foreman	141 "
Labor	620 "
Work Cars	48 "
Item #21	
Superintendent	184 "
Item #22	
Steam Fitters	4 "
Helpers	4 "
Time Keeper	184 "
Watchman	74 "
Waterboy	172 "
Machinsts	24 "
Electricians	28 "

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

MATERIAL PLACED

Item #7 Basement Floor Repairs.	
Cement	2½ bbls.
Bank Sand	½ C.Y.
Item #8 Main Floor Stair Repairs	
Cement	4 bbls.
Bank Sand	1 CY.
Item #9	
Grout toilet and office roof	
Cement	4½ bbls.
Bank Sand	1½ C.Y.
Beaded Stretchers	150 pcs.
Quoins	2 "
Cement	1 bag
White Sand	1 "
Item #10 South Stairway and Railing and North Stairway Railing.	
Douchy Iron Works	
Amount of contract completed	100 %
Iron Fire Doors for boiler room (old)	234 lbs.
Item #11 Basement Closet Door 2' 8" x 7' x 1 5/8" panelled oak	2 pcs.
½ round oak base moulding	150 ft.
South Door Hinges, C.I.	150 "
" " Pulls	½ pc.
Item #15	1 "
Boiled Oil	5 gal.
Turpentine	4 "
Builder's Gray	20 "
Varnish	5 "
White Lead	50 lbs.
Burnt Senia	1 lb.
Rosiania	5 "
Graining Covering	1 "
Sand Paper Sheets	2 doz.
Florentine Glass, 3 pieces, 2' x 3'	18 sq. ft.
Item #16 Fittings for Sump Pump discharge.	
Malleable Iron Pipe	5½ ft.
C.I. Ells, 1"	2 pcs.
C.I. Ells 1" 45 deg.	1 pc.
C.I. Couplings 1"	1 pc.
Expansion Screws	4 pcs.

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

MATERIAL PLACED

Item #17 Asbestos Composition Flooring Company	
Composition	186 bags
Item #18	
Boiler Room Supports	
Std. 3" T. Irons	250 lbs.
Item #19	
D. B. Wire #14	300 ft.

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

LABOR

Item #7	
Cement Finishers	28 hrs.
Labor Foreman	33 "
Labor	92 "
Item #8	
Cement Finisher	72 "
Helpers	92 "
Labor Foreman	102 "
Labor	310 "
Carpenter	13 "
Item #9	
Labor Foreman	12 "
Labor	31 "
Cement Finisher	16 "
Helper	16 "
I.P. Crane	
Brick Washers	93 "
Item #10	
Douchy Iron Workers	
Iron Workers Foreman	8 "
Iron Workers	40 "
Machinists	22 "
Item #11	
Cement Finisher	8 "
Helpers	8 "
Labor Foreman	8 "
Labor	16 "
Carpenters	86 "
Item #15	
Painters	387 "
Item #16	
Carpenters	16 "
Item #19	
Electricians	10 "
Item #17	
Asbestos Composition Flooring Company	
Finishers	145 "
Helper	101 "
Labor Foreman	1 "
Labor	4 "
M. S. O'Day	
Brick Layers	12 "
Helpers	12 "

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

LABOR

Item #20	
Labor Foreman	58 hrs.
Labor	165 "
Carpente r	40 "
Item #21	
Superintendent	176 "
Item #22	
Time Keeper	12 "
Watchman	6 "
Water Boy	24 "

ENGINEER'S MONTHLY ESTIMATE.

January, 1910.

MATERIAL PLACED

Item #10	
Douchy Iron Workers	
Contract Complete	
Wrought Iron Window Guards	10 pcs.
" " " Screen	2 "
E. R. Landon Iron and Wire Works	
Iron Fire Ladder 52.5' long	
Iron Crane Ladder 19.5' long	
Contract completed	100 %
Item #15	
Boiled Oil	6 Gals.
Drop Black	5 lbs.
Std. Glass	48 Sq. Ft.
Item #16	
Galvanized Hot Water Tanks with Coil	1 pc.
Item #17	
Asbestos Composition Flooring Company,	
Contract completed	100 %
Item #19	
Knife Switch Quick Brake S.P.S.T. 25 ampere	
500 volt	16 pcs.
Noark Fuses 4 ampere	16 pcs.

ENGINEER'S MONTHLY ESTIMATE.

January, 1910.

LABOR

Item #10	
Douchy Iron Workers	
Machinists	56 hrs.
Chicago Ladder Company	
Iron Workers	22 "
Item #15	
Painters	53 hrs.
Item #16	
Steam Fitters	40 hrs.
Helpers	40 "
Item #17	
Asbestos Composition Flooring Company	
Finishers	24 "
Helpers	24 "

ENGINEER'S MONTHLY ESTIMATE.

February, 1910.

MATERIAL PLACED

Item #16

J. L. Schurman automatic switch for Sump Pump	1 pc.
$\frac{3}{4}$" Conduit 20'	20 ft.
R. C. Rubber Covered Wire #10	100 Ft.
Angle Iron	104 lbs.
Iron Pipe $1\frac{1}{2}$"	15 ft.
C.I. Ells $1\frac{1}{2}$"	1 pc.
C.I. Flange $4\frac{1}{2}$"	1 pc.
Brass Pulley $2\frac{1}{2}$"	2 "
Bolts and Nuts	8 lbs.

LABOR

Machinists	64 hrs.
Electricians	8 "
Labot at Van Buren Street Machine Shop.	
Machinists	27 "
Black-smith	27 "
Helper	36 "

ENGINEER'S MONTHLY ESTIMATE.

March, 1910.

MATERIAL PLACED

Item #10	
Stair Hand Railing	
1½" Malleable Globe Ts'	4 pcs.
1½" " " Ells	4 "
1½" " " " 2 way	1 pc.
1½" C.I. Flanges.	5 pcs.
1½" Malleable Iron Pipe	43 ft.
1½" " Globe Ts'	1 pc.

LABOR

Item #10	
Steam-fitters	28 hrs.
Helpers	28 "
Item #19	
Lighting	
Electricians	16 hrs.
Item #20	
General Clean-up	
Foreman	14 hrs.
Labor	56 "

ENGINEER'S MONTHLY ESTIMATE.

April, 1910.

MATERIAL PLACED

Item #19	
3 Light Harter Cluster	1 pc.
16 Candle Power Benjamin Sockets	2 pcs.
#14 Duplex Copper Wire	25 ft.

LABOR

Item #19	
Electricians	16 hrs.

ENGINEER'S MONTHLY ESTIMATE.

May, 1910.

MATERIAL PLACED

Item #15
Painting Hot Water System
Trolley Black 1 Gal.

LABOR

Item #15
Painters 16 hrs.

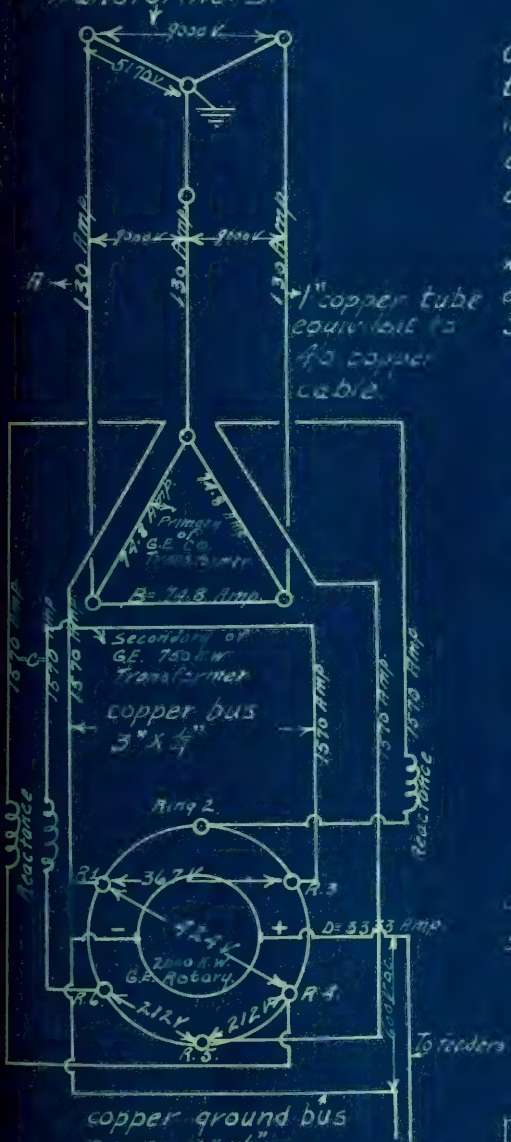
ROTARY CONVERTERS:

A Rotary Converter is essentially a D. C. Generator possessing besides the ordinary commutator, several collection rings which are connected with the armature winding at corresponding points,. When this machine is driven through the application of mechanical power it delivers either direct or alternating current. If, on the other hand electrical energy is employed to drive the machine, available mechanical energy will be the result. It is thus evident that the machine can be run either as a synchronous or D. C. motor or as a converter of a.c. current,with D. C. currents or vice versa.

When the converter acts as a D. C. generator the switching arrangements are almost identical with those of the ordinary D. C. machine.

C. Rys Co Sub-Station

Secondary of Fish St Transformers.



The calculations below for currents and voltages do not take into consideration losses in the transformers, reactance and rotary which are comparitively small

The A.C current 130 amp (9000 V) was recorded when the unit was delivering approximately full load 3333 amp at unity power factor.

Sample Calculations - Full Load

Voltage from Y to ground

$$\frac{9000}{\sqrt{3}} = 5170 \text{ volts}$$

Current in H.T lead is 130 amp.

Current in $\Delta = \frac{130}{\sqrt{3}} = 74.8$ amp.

$E_p I_p = E_s I_s$ approx

$\frac{9000 \times 74.8}{424} = 1570$ amp $= E_c \cdot I_c$

$I_o = \frac{I_c \times N}{2 \times \sqrt{2}} = \frac{1570 \times 6}{1.41 \times 2} = 3333$ amp.

Voltage across different rings

$E_{R1} = \frac{E_o}{2} \sin \frac{180}{6}$

$E_{R6} = \frac{600}{1.41} \sin \frac{180}{6} = 212$ V.

$E_{R3} = \frac{600}{1.41} \sin \frac{180}{3} = 367$ V.

$E_{R2} = \frac{600}{1.41} \sin \frac{180}{2} = 424$ V.

Rule for size of bus bar

copper — 200 amp/sq in cross section

% Load	Amps A H.T. Line	Amps B	Amps C	Amps D
100	130	74.8	1570	3333
111	144.2	83.4	1745	3710
125	162	93.5	1955	4166
150	195	112.4	2350	4999
200	260	149.7	3130	6666

Jos. H. Jacobson.
Dec. 1909

ELECTRICAL CONSTRUCTION.

After the building's concrete foundations are placed and the forms for the concrete rotary walls are in readiness, the electricians place the ground plate adjacent to the rotary forms. This ground plate is a piece of copper 4' [illegible] 30" X ¼" and connected to 2-350,000 C. M. Stranded tined cable. A ditch is dug the depth of the water level and three bags of charcoal are first thrown in and then the ground plate placed and three bags of charcoal thrown over it. The cable is brought up between the rotary wall forms to the first floor where it is afterward distributed to each of the rotary transformer, reactance, potential transformer, frames, also the structural iron work and sheath of 9000 V Edison Cable. All of the above apparatus just mentioned must be grounded. In the rotary forms are placed bolts for the bus bar bracket supports and also conduit necessary for basement lighting and power.

After having completed the above the next step will be toward concreting. The Conduit as shown in Drg. "Conduit and Wires" is placed over the I beam supports before the concrete is poured and great care must be taken to see that no conduit has been omitted as in this drawing, as bell circuit, crane trolley, telephone, pump, end play mechanism behind switch board, ground cable, blower conduit, arc and incandescent light circuit.

Each rotary has six bare 1,000,000 C.M. grounded cables brought up to the ground bus (2-10" X ¼" copper) which is located under the machine attached to the rotary wall.

These ground cables are pulled through underground tile ducts from the man holes, outside of the station and thence to the different tracks. All conduit work is grouted in by concrete.

The Sub-station receives 25-cycle 9000 volt three-phase current from the Common Wealth Edison Company's high tension lines and delivers 600 volts direct current to the railway feeder system.

The high-tension three phase current is supplied to each of the 2000 Kilowatt units through a separate underground feeder cable, entering the sub-station through a motor operated oil switch, connecting the lines to a short bus bar; this bus bar can be connected either to one bank of three transformers through a motor-operated oil switch, or to a transfer bus bar through a hand operated disconnecting switch.

This transfer bus bar permits any one of the transmission lines to be connected to any desired unit, and also permits any desired number of units to be run in parallel.

The converters are started from the alternating current side by means of two double throw three pole switches connected to transformer taps giving 1/2, 2/3 and full voltage.

No provision has been made for the synchronizing or the dirrect current starting of the converters so that the number of switchboard attachments has been reduced to a minimum.

The high-tension potential transformers and their detachable fuses, located in small brick structures protected by wood and glass sliding doors, are placed close to the wall of the station.

The high-tension switches enclosed in brick structures are arranged in a single row in front of the potential transformers. On the side facing the potential transformer compartment the oil switches have wooden cell doors and the transformers and reactances are placed close to the oil switches on the other side.

The rotary converters and the main switchboard form two more rows with ample space between them.

Most of the space in the basement is occupied by a large air chamber with a battery of motor-driven blowers at both ends supplying the air blast necessary for the cooling of the transformers and reactances.

The incoming lines, the high-tension bus bars, the current transformers, and the disconnecting switches are located in the air chamber.

The bus bars are entirely enclosed in an alberene stone and lemon Sparta brick structure and additional partitions are used to separate and protect the instrument and the conductors of different phases.

OPERATION OF SELF-STARTING SYNCHRONOUS CONVERTER WITH FIELD BREAK UP SWITCH.

It is customary, in connection with self-starting synchronous converters to provide a combined field break-up and reversing switch mounted on the frame of the machine. This switch is connected in the field circuit at several points which is thrown open during starting, thus preventing an accumulation of the voltage induced in the field by the alternating current applied to the armature.

When the alternating current circuit is connected to the armature of a self-starting synchronous converter, the polarity on the direct-current side of the converter is not fixed, i.e, it may build up "right" or "reversed". At the moment the machine is connected to the alternating current circuit, the field break up and reversing switch is open, there is no current flowing in the field coils and the converter starts as an ordinary induction motor.

At first the needle of the voltmeter, connected across the direct-current terminals will swing back and forth and it will only begin to point steadily in one direction after the speed has nearly reached the synchronous value.

In case the polarity happens to be the one desired the field switch is closed. After this is done, the direct-current voltage will continue to build up and the full alternating line voltage can be applied. In case the direct current voltage builds up reversed, the field switch is thrown in what is termed the "reversed" position. In this case the current flowing through the field coils cause the flux to oppose the armature flux, the direction of the latter being fixed by the alternating current. As is well known the rotating field set up by the alternating current results in a flux which is stationary with respect to the field poles, when the armature is running at synchronous speed, the same as the flux introduced by the field coils.

Hence the conditions explained above means that the two resulting fluxes are opposing one another. This condition can only result in either the armature flux over-coming the field flux or vice versa. If the armature flux remains the stronger, the converter will continue to operate with reversed polarity and under very unstable conditions. If the field flux becomes the stronger it will tend to destroy the armature flux and the result will be that it will push the armature flux aside, i.e, out into the space between the poles, where

upon it will be displaced until it coincides with the field flux of the respective adjacent poles. This action is designated by stating that the converter "slips a pole".

When the armature flux is being pushed over from one pole to another the direct current voltage passes from a certain value at one polarity through zero and then begins to build up with reversed polarity. Simultaneously the field current passes through the same cycle and therefore at the moment that the direct-current voltage starts to build up in the opposite direction, the field switch will have to be thrown over so as to prevent the field flux from again building up in a reversed direction relative to the armature flux.

It is therefore, because of this reversal of the armature flux, that the field switch is to be thrown over at the instant the converter slips a pole. The field rheostat is not connected in the circuit when the field switch is thrown in the reverse position, inasmuch as this position does not correspond to a normal operating condition, but is used for starting only and moreover because it is necessary to get the greatest current possible through the field coils, in order that the desired reversal and slipping of a pole shall take place.

A method of connecting the alternating-current circuit of the armature to the transformer arranged for six phase operation and self-starting by means of two double throw switches, and connections of the shunt fields to the field break up switch, are shown on blue print #M-832732.

INSTALLATION OF MACHINERY.

Most machinery is brought to the Sub-station in Railway work cars from the depot and rolled into the building by means of block and tackle. This work is done by riggers. The cost of installing machinery and constructing a station is increased or decreased to a certain extent according to the distance material must be hauled. The 25 ton crane is delivered by the riggers and installed by the iron workers and wired by the electricians, trolley being used for conveying the power.

After the concrete has dried and the form lumber removed, the engineer lines up the rotary sole plates and the machinists level and grout them in with cement. This is the most careful piece of work in the station because if this is off the rotary will not set correctly. After the cement has set we are now ready for the bottom field and next the bearings and armature, and finally the top field. All the above parts are bolted down through the concrete wall by heavy 3" bolts. See Drg. for setting sole plates M 832726.

SPECIFICATIONS FOR ELECTRICAL APPARATUS

FOR AND IN CONSIDERATION of price named herein, the Company proposes to furnish the following apparatus F.O.B. Schenectady, N. Y., to be in accordance with specifications attached hereto:

3-HC-16-2000-188-600 volt CW rotary converters complete with field rheostats, speed limit and end play device.
3-300 KVA. A.B. reactive coils, with starting panels mounted thereon.
9-AB. 25-750-9000-430 V. single phase air blast transformers, with four (4) 2-1/2% taps in primary and 1/3 and 2/3 voltage starting taps in secondary.
3-20000 cu. ft. blower sets each consisting of 90" B.F. Co. Fan, direct connected to 1-6-7-1/2-500-350 V. Induction motor.

SWITCHBOARD:

3-9000 V. incomings line panels
3-2000 KW 9000 V. AC. rotary panels
3-2000 KW D. C. rotary panels
1-DC Battery panel, including charging rheostat
1-750 V. voltmeter on bracket.
3-7-1/2 HP blower panels
D. C. bus supports
Wall braces and couplings
Copper tube connections
A. C. bus supports and clamps
1-Storage Battery sufficient capacity for the above.

SHIPMENT:

Shipment of two of the above rotaries is to be made in four (4) to four and one-half (4-1/2) months, and two (2) every 30 days thereafter; switchboard in 2-1/2 months from date of receipt of order.

GENERAL ELECTRIC COMPANY

Schenectady, N. Y. , U. S. A.

SPECIFICATIONS FOR ROTARY CONVERTER

For CHICAGO RAILWAYS COMPANY

Classification, H. C 16-2000-188 Number of Poles, 16

Rated Kw. Capacity, 2000 Revolutions per minute 188

Full Load Direct Current, 3333 Amperes. D. C. Voltage from 600to600

Voltage to which Kw. rating applies, 600 Cycles, 25

MAGNET FRAME

The magnet frame will be circular in form and made of cast iron of high permeability and will have 16 inwardly projecting poles. It will be divided horizontally so that the upper half can be lifted up to provide for inspecting or removing the armature. The seats for the pole pieces and the joints between the two halves of the yoke will be accurately finished. The seats for the bolt heads and nuts will be faced.

POLE PIECES.

The pole pieces will be made of Cast steel with laminated faces and will be fastened to the magnet yoke by bolts so that any pole piece and field spool can be removed without disturbing the armature or magnet yoke.

FIELD COILS.

The field coils will be compound wound, and all parts of the winding will be carefully insulated with materials of the best quality, well ventilated and thoroughly tested.

ARMATURE

ARMATURE SPIDER.

The armature spider will be made of cast iron so designed that all shrinkage strains will be avoided. The hub of the spider will be made amply long and will be bored and scraped accurately to gauge and key-seated.

LAMINATIONS.

The armature punchings or laminations will be made from the best material thoroughly annealed and securely keyed to the spider. They will be accurately punched and before being assembled will be thoroughly japanned to prevent eddy currents.

VENTILATING DUCTS.

At certain intervals, space blocks will be inserted between the laminations so as to provide ventilating ducts for cooling the core and windings.

END FLANGES.

The laminations will be held in place by end flanges of cast iron which will also serve to support the winding. The bolts which hold these end flanges WILL NOT PASS THROUGH A MAGNETICALLY ACTIVE PORTION OF THE LAMINATIONS.

SLOTS.

Slots will be punched in the periphery of the laminations to receive the armature conductors.

INSULATION.

The conductors will be carefully insulated from each other with suitable fabric and varnish, and from the core with suitable varnished fabric and horn fibre.

The armature conductors will be retained in the slots by means of wooden wedges.

ARMATURE CONDUCTORS.

The armature conductors will be made up of copper bars of high conductivity, bent on a form into the proper shape so that they can be laid in the slots without difficulty and will be interchangeable.

COMMUTATOR

METHOD OF ATTACHMENT.

The commutator will be supported on an extension of the armature spider to which it is keyed, or keyed directly to the shaft, thus preventing any relative movement between the commutator segments and the armature conductors.

BARS.

The commutator bars will be of hard drawn copper and finished accurately to gauge.

INSULATION.

The insulation will consist of carefully selected mica, accurately fitted.

CLAMPS.

The bars will be held firmly in place by clamping rings so that no displacement will be caused by expansion and contraction.

CLAMPING BOLTS.

The bolts of the clamping rings will be easily accessible for purposes of tightening and removal for repairs.

INSULATING MATERIAL.

To prevent arcing from the brushes to the clamping rimgs and also surface leakage, suitable insulating material will be placed between the ends of the segment and the clamping rings.

VOLTS PER BAR.

The average difference of potential between adjacent commutator segments will not exceed 14.5 volts when the machine is running at 600 volts.

BRUSH-HOLDERS AND BRUSHES.

The brush-holders are so constructed that the tension on any brush can be adjusted without lifting the brush from the commutator and without the use of any tools. Any brush can be removed while the machine is in operation without disturbing the others and without moving the holder on the stud. Flexible connections to the brushes are used which prevent injurious currents in parts of brush-holder mechanism.

The commutator and brushes will be so proportioned that they will operate in the most efficient manner within the desired temperature limits.

BRUSH-HOLDER SUPPORT AND SHIFTING DEVICE.

The brush-holders will be supported by a suitable mechanism and a shifting device will be provided for adjusting the position of all the brushes simultaneously.

COLLECTOR

The collector rings will be of cast copper supported by a cast iron shell, insulated from it by mica and fibre. Sufficient space will be allowed between them to prevent leakage. The brushes will be of copper.

BASE AND BEARINGS.

STANDARDS.

The base and bearing standards will be of cast iron, The standards will be cast with the base, or will be separate castings doweled to the base, thus insuring accurate and permanent alignment.

The bearings will be self-oiling and self-aligning with ample surface to insure cool running.

SHAFT

The shaft will be of forged steel in one piece and accurately finished to gauge.

PERFORMANCE

TEMPERATURE RISE.

After a run of 24 hours at 3333 amperes and 600 volts the temperature of no part of the armature or field coils as measured by the thermometer will be more than 35 deg. C. or that of the commutator and collector more than 35 deg. C. above that of the air surrounding the machine. With the load then increased to 5000 amperes and 600 volts (150% full load) for 2 hours, the temperature of no part of armature or field coils will be more than 55 deg. C. or the temperature of the commutator and collector more than 55 deg. C. above that of the air surrounding the machine, providing the conditions of ventilation are normal. In the event of the temperature of the surrounding air differing from 25 deg. C., the above rise in temperature is to be corrected by ½% for each degree C. that the temperature of the surrounding air differs from 25 deg. C.

OVERLOAD - CAPACITY.

The machine will carry an overload in current of 50% at 600 volts for 2 hours without movement of brushes and without injurious sparking, and 100% overload at 600 volts momentarily without flashing over or injurious sparking.

INSULATION TEST.

The insulation between field coils and magnet frame willwithstand an insulation test of 5000 volts alternating current for 60 seconds, and between armature winding and armature core will withstand an insulation test of 2000 volts alternating current for 60 seconds,.

EFFICIENCY.

The commercial efficiency at 600 volts will be as follows:

1½ load----------97 %
Full load----------96½ %
¾ load----------96 %
½ load----------94½ %

In calculating the commercial efficiency, ALL LOSSES, including those in the commutator, brushes and bearings, have been taken into account.

WEIGHT

The total net weight of the armature will be approximately 48000 lbs.

The total net weight of the machine will be approximately 123000 lbs.

Machine complete without base but with sole plates.

G E N E R A L E L E C T R I C C O M P A N Y

Schenectady, N. Y., U. S. A.

SPECIFICATIONS FOR AIR BLAST TRANSFORMERS

Classification AB 25- 750-9000-430

For CHICAGO RAILWAY'S COMPANY

Rated Kw. Capacity 750 at 25 cycles.

Volts (Primary 9000 taps 8775/8550/8325/8100
(Secondary 430 1/3 and 2/3 starting taps

Amperes (Primary 83.4
(Secondary 1745

Ratio of Transformation with full windings in circuit 20.9;1

Air Required 2050 cu. ft. Per Min. at 3/4 oz. pressure

GENERAL CONSTRUCTION

The general design of the transformer will be that having flat wound primary and secondary coils arranged vertically and surrounded by a laminated sheet steel core.

The transformer will be provided with a substantial iron base, a cast iron cap and sheet iron casing. One side of the casing will form a chamber for the supply of air to the transformer and the opposite side will be perforated to allow the escape of the heated air.

Register gates at the top, and at one side of the transformer will provide for the control of the air supply to the coils and to the core.

CORE

LAMINATIONS.

The core will be built up of steel laminations having high permeability and low hysteresis loss and will not be subject to appreciable magnetic deterioration. The laminations will also be carefully annealed and will be insulated from each other to reduce eddy current losses.

WINDINGS

COILS

The primary and secondary windings will be subdivided into

several coils, each of which will be built up of flat conductors arranged with one turn per layer so as to form thin, high coils which will present a large radiating surface to the air.

INSULATION.

The conductors will be cemented together with a special insulating compound, after which exterior insulating wrappings will be applied and separately treated with an insulating varnish, making a very durable insulation, capable of resisting a potential strain much greater than that for which the transformer is designed.

INSULATING DIAPHRAGMS.

A continuous insulating diaphragm rigidly held in position by spacing channels covering the edges of the coils, will be placed between adjacent primary and secondary coils.

INSULATING CASING.

The assembled coils will be completely enclosed except at the end, by continuous sheets of insulation which will interpose a substantial barrier at all points between the windings and the core.

VENTILATING DUCTS.

The coils will be separated from each other by air spaces and frequent open spaces or ducts will be provided in the core so that air can be forced through the entire structure to maintain the low temperature necessary to avoid deterioration.

TERMINALS

LOW POTENTIAL

The low potential terminals will be situated in the base of the transformer and openings in the sides of the base will give access to them when not readily accessible from the air duct under the transformers.

HIGH POTENTIAL.

The high potential leads will consist of cables brought through heavy porcelain bushings located in general in the bases.

COUPLINGS.

The leads will be provided with couplings to facilitate rapid connection or disconnection from the lines.

PERFORMANCE

TEMPERATURE RISE.

After a run of 24 hours at 25 cycles 9000

volts, and 83.4 amperes, the rise of temperatureof any part of the transformer as measured by thermometer, will not exceed 35 degrees Centigrade, and the rise in temperature of the coils as measured by the increase in resistance will not exceed 35 degrees Centigrade above the temperature of the ingoing air provided the temperature of the ingoing air is 25 degrees Centigrade, the conditions of ventilation are normal, and corrections for variations from normal temperature and atmospheric pressure are made in accordance with the Standardization Rules of the A. I. E.E.

OVERLOAD.

After reaching ultimate temperature at rated load the transformer will carry an overload of 25% for 2 hours without exceeding 55 degrees C. rise.

INSULATION.

The insulation between the primary coils and the core, and between primary and secondary coils, will stand a test of 18000 volts alternating current for one minute; and between secondary coils and the core a test of 2500 volts for the same length of time. Windings will withstand a high voltage test of double the rated potential which will be applied directly across the terminals of the winding for one minute.

EFFICIENCY.

The transformer will have efficiencies not lower than the following:

¾ load----------98.3
Full load----------98.3
¾ load----------98.2
½ load----------97.8
¼ load----------96.2

The regulation on non-inductive load will be approximately 1.0 %

APPROXIMATE DIMENSIONS AND WEIGHT

A------98"

B------46"

C------50"

Total weight 13000 lbs.

The secondary winding will have a full KW. capacity tap for 360 volts.

SPECIFICATIONS FOR SWITCHBOARD

FOR

CHICAGO RAILWAYS COMPANY.

Material of panels will be Black Enameled Slate.
Instruments will have a dull black finish.
Panels will be mounted on pipe supports.
Card-holders supplied where necessary.

Switchboard will control:

3- 9000 V. 2000 KW. 3-phase 25 cycle incoming lines.
3- 600 V. 2000 KW. compound wound rotary converters, with transformers stepping down from 9000 V.
3- 350 V. 7.5 H.P. 3-phase 25 cycle blower motors. (Starting panels included with reactive coils.)

Switchboard will consist of:

3- 3-phase incoming line panels.
3- A. C. Rotary panels.
3- D. C. rotary panels.
1- Battery panel.
1- Swinging bracket with D. C. voltmeter
3- Blower motor panels.
D. C. Bus bar supports and clamps.
Panel wall braces and inculated couplings for same.
Copper tube connections.
Supports and clamps for A. C. bus and connection bars.

Item #1.

3- 3-phase incoming line panels.
Capacity 9000 V. 2000 K.W.
Size- (Top section 34 X 16 X 2"
(Middle " 46 X 16 X 2"
(Lower " 28 X 16 X 2"

-Equipment per panel-

1- 300 amp. H.E. A.C. ammeter.
1- 150 KW. H.E. A. C. voltmeter (To be mounted on rotary panel)
3- 52 V. 5 amp. S.Ph. "IS-3" recording wattmeters front of panel.
1- 2 point potential receptacle.
1- S.P.D.T. control switch with indicating lamps.
1- T.P.S.T. 15000 V. 300 amp. "H-3" automatic oil switch.

SPECIFICATIONS FOR SWITCHBOARD

#23393

motor operated, complete with cell doors, cell tops and bottoms, litholyte barriers, channel irons, clamps, tie rods, bushings and terminals.
3- S.P.S.T. 15000 V. 300 amp. disconnecting switches on slate bases (8X14X2)
1- T.P. inverse time limit relay.
3- 11000/110 V 200 wat potential transformers.
1- 8800/110 V. 200 watt potential transformers.
3- 300 amp. "D-21" current transformers.
6- 200 amp. " " "

Item #2

3- A.C. rotary panels.
Capacity 9000 V. 2000 KW.
(Top section 34 X 16 X 2"
(Middle " 46 X 16 X 2"
(Lower " 28 X 16 X 2"
-Equipment per panel-
1- 250 amp. H.E. A.C. ammeter,
1- 110 V. 5 amp. H.E. balanced 3-phase power factor indicator with 60-100-60% scale (Drilling only)
1- S.P.D.T. control switch with indicating lamps.
1- T.P.S.T. 15000 V. 300 amp. "H-3" automatic motor operated oil switch complete with cell doors, cell tops and bottoms, litholyte barriers, channel irons clamps, tie rods, bushings and terminals.
3- S.P.S.T. 15000 V. 300 amp. disconnecting switches. on slate bases (8X14X2)
1- T.P. inverse time limit relay.
3- 300 amp. "D-21" current transformers.

Item #3

3- D.C. rotary panels.
Capacity 600 V. 2000 KW.
Size - (Top section 34 X 24 X 2"
(Middle " 46 X 24 X 2"
(Lower " 28 X 24 X 2"
-Equipment per panel-
1- S.P. 650 V. 6000 amp. "CK" circuit breaker, with low voltage release and bell alarm switch.
1- 6000 amp. T.I.D. ammeter with shunt.
1- Chain operating mechanism for field rheostat.
1- 2 point potential receptacle.
1- S.P.S.T. 600 V 5000 amp. "D-12" lever switch.

SPECIFICATIONS FOR SWITCHBOARD

#23393

1- S.P.D.T. 600 V. 200 amp. "QC-2" lighting switch
1- 600 V. 4000 amp. T.R. wattmeter, 2-wire, form "G-2"
1- "MD-2" lightning arrester with brackets.

Item #4

1- D.C. Battery panel.
Size- (Top section 62"X 24"X 2"
(Middle "
(Lower " 28"X 24"X 2"

Equipment-Item #4

1- 30-0-100 amp. T.F.T. ammeter with shunt.
1- Chain operating mechanism for rheostat.
1- Battery charging rheostat.
1- S.P. 250 V. 30 amp. enclosed fuse block and fuse for operating circuit, on base back of panel.
3- S.P.S.T. 600 V. 200 amp. "C-21" lever switches
2- S.P. 600 V. 100 amp. enclosed fuse blocks and fuses on base back of panel.
1- Low voltage relay with resistance.

Item #5.

1- Swinging bracket. Cat. #58435, containing--------
1-750 V. T.I.D. voltmeter, permanent magnet type,
1- 2 point potential plug.

Item #6.

3- 3-phase blower motor panels, Cat. #30329
Capacity 350 V. 7.5. H.P.
Size 28 X 16 X1-1/2" on 64" pipe supports.
-Equipment per panel-
1- T.P.D.T. 500 V. 100 amp. "D-12" lever switch.
3- Enclosed fuses on front of panel.

Item #7.

D. C. bus bar supports and clamps.
(Bus bars supplied by Purchaser.)

Item #8

Panel wall braces and insulated couplings for same.

SPECIFICATIONS FOR SWITCHBOARD

Item #9

Copper tube connections.

Item #10

Supports & Clamps for A. C. bus and connection bars.
(A.C. bus bars supplied by Purchaser)

SPECIFICATION

FOR

AN ELECTRIC TRAVELING CRANE

FOR SUBSTATION

FOR THE CHICAGO RAILWAY COMPANY.

SCOPE:

This specification is intended to cover all of the work in connection with the manufacture and installation of an electric traveling crane in substation.

DEFINITION OF TERMS:

Whenever the words "Chief Engineer of the Work" are mentioned, they refer to the Chief Engineer mentioned in the Ordinance as having general charge of the work of rehabilitation, or his authorized representative.

Whenever the words "Engineer in Charge" are used they refer to the Chief Engineer of the Chicago City Railway Company, or his authorized representative.

Whenever the word "Company" is used it means the Chicago City Railway Company.

Whenever the word "Constructor" is used it means the Chicago City Railway Company, or its duly authorized agent.

In case of a misunderstanding or disagreement arising between any of the interested parties as to the intent or meaning of the plans of specifications covering the work, or should a question of fact arise as to whether or not the work is being performed in accordance with the plans and specifications, the decision of the Chief Engineer of the Work shall be final in all such matters, unless the Board shall, at a subsequent meeting, overrule his decision.

DRAWING :

The attached drawing #2222, shows the clearance and overall dimensions.

GENERAL DATA:

The crane shall be a three (3) motor, electric traveling crane operated from cab:

Capacity	25 Tons
Gauge to gauge of Runway Rails	45'
Maximum lift of Hook	33' 0"
Working voltage for all motors and electrical apparatus	600 V. D. C.

The runway service wires will be located on the web of the south runway beam and will be #2/0 B. & S. gauge, hard drawn copper wire. Runway wires and supports for same will be furnished and erected by the Chicago Railway Company.

The constructor shall furnish and install suitable runway rail stops. The runway rail is to be 60# A. S. C. E. Section.

DESIGN:

The general design of the crane as regards head room, distance of bottom of girder above rail, etc., is limited to the figures and dimensions shown on drawing #2222.

This constructor is to furnish the Chief Engineer of the Work and the Engineer in Charge proper sketches of the crane proposed to be furnished, giving all clearance figures, etc., which must in no case be less than those called for on drawing #2222.

Shop work on the crane must not be commenced until the above sketch has been aprroved by both the Chief Engineer of the Work and the Engineer in Charge.

FACTOR OF SAFETY:

By the factor of safety as here used is meant the ratio of yield point of material used to the greatest working stress the structure will be called upon to withstand. For the bridges proper this ratio shall be at least 4 when under full load. Make also proper allowances for impact and shock due to sudden starting and stopping.

All pins and journals shall have their factor of safety increased above that mentioned to bring the values for bearing and deflection well within the limits used in first-class, permanent machine design.

BRIDGE:

The bridge shall be built up of steel built girders of such design and weight so as to comply with this specification and drawing #2222. At least one-half of the net area of the flange of girder must be made up of angles only.

All materials used in the construction of bridge girders shall conform to the specifications adopted by the Association of American Steel Manufacturers.

BRIDGE DRIVE:

The crane will be carried by end trucks and double flanged wheels of ample size and strength to take the maximun load when same is lifted at one end of the bridge. The wheels shall be chilled and ground true to diameter and face to insure uniform travel. The bridge shall be controlled by a powerful brake, mechanical in action; of an approved design. This brake shall be so located that same may be readily operated by the attendant.

TROLLEY:

The trolley of the crane shall be of such design, pattern and weight as to properly handle, control and operate under all conditions from light load to the load limit.

HOISTING ARRANGEMENTS:

The hoisting arrangement shall be of design and size, so as to take the full run of rope for the specified lift without over lapping or excessive side pull. The arrangement of the blocks and rope attachment shall be such that the block will hang midway between the bridge girders at all times.

The hoisting drum shall be provided with a device to automatically open the electric circuit of the hoisting motor; in the event that the hook and block should be raised above a predetermined height.

HOOK, BLOCK AND ROPE:

The hook and block shall be of an approved type of swivel design. The hook shall be of the best quality forged steel used for the purpose and shall be so designed to carry and lift the heaviest loads.

The block shall be provided with hardened steel cones, which shall contain steel balls, to insure free turning when loaded. The sheaves of this block shall be as large as it is consistent with good practice to use and shall be carefully grooved and fitted with bronze bushings and pins.

The cable shall be of the proper size of the best grade of flexible steel wire rope, in one piece containing no splices.

BEARINGS:

All bearings used throughout the trolley , bridge and hoisting sheeves shall be of ample size, properly fitted to the bearing shaft and the bearing seat. All bearings shall be of the best grade of phosphor bronze suitable for this purpose.

All bearings shall be provided with the proper means for lubrication and shall be readily accessible.

All motor bearings shall be provided with oil wells and oil rings of an approved type.

GEARS:

All gears used throughout this crane shall be cut from special hard and tough steel. All pinions shall be cut from forged steel blanks. All gears and pinion teeth shall be cut to insure the proper face and pitch, and shall be so proportioned to secure the greatest strength and durability to suit the maximum load and speed. The number of gears used in each motion shall be reduced to the minimum consistent with good practice. All gears when same is possible shall be enclosed in tight cases.

BRAKES:

Two distinct means of breaking and sustaining loads shall be provided on the trolley, this to be accomplished and so arranged that electric power shall be required to raise or lower a load. These brakes shall be capable of sustaining the full load automatically at all times.

One brake shall be electrical and one mechanical in action.

OPERATOR'S CAGE:

The operator's cage of this crane shall be fastened to end of the crane which will be nearest the south wall and shall be located on the left-hand side facing this wall.

This cage shall be fastened to the bridge truss with suitable steel forms and braces to properly sustain the loads to be put upon it and to hold same rigidly at all times.

The cage shall contain the necessary speed regulators, switch and fuse terminal cabinet, and permit of ample room for the operator in performing his duty, whether running the crane or making repairs to apparatus therein contained.

This cage shall be so located that same will not imterfere with the travel of the trolley or shorten the runway span of the bridge in any way.

MOTORS:

All motors shall be specially designed; series type manufactured for this class of service only, make, type and form to meet the approval of the Chief Engineer of the Work and the Engineer in Charge. All motors must be of the four pole type, each pole to be made of laminations securely fastened to a cast steel frame.

Each motor shall have its four poles directly magnetized by a separate and proper field coil. Each motor shall be entirely closed and so constructed that access may be had to the commutator and coil end of the armature. These motors shall be of sufficient size and capacity to deliver the required power without undue heating when entirely enclosed. The rating of all motors should indicate the hourse power that may be developed without more than 40 Cent., rise in temperature, measured at a starting point at or below 25 Cent., with the motor entirely enclosed for one-half hour.

All armature to be made of the form-wound coil type, and shall be made of the required number and proper form of soft steel punchings to properly house the coils.

The commutator of each armature shall be mounted upon the spider or core of the armature to facilitate the removing of the shaft without disturbing the windings or connections.

All motors shall be provided with suitable name plates setting forth the Maker's name, Type, Form, Voltage, Current, Horse Power and R. P. M.

SPEED REGULATORS:

Suitable speed regulators shall be provided for each motor and installed in the operator's cage. Each speed regulator shall be capable of regulating the speed in either direction and with any load.

The resistance of each speed regulator shall be so determined and proportioned to properly handle and permit gradual starting of the lightest and heaviest loads, and the maintaining of each speed indefinitely on any point of the regulator from no load to full load.

The speed regulators shall be constructed from fireproof material throughout. The resistance members of each speed regulator shall be securely encased, and be so constructed that it will be thoroughly ventilated, and will not permit of any flame being emitted or molten metal falling, should same be destroyed by the current.

All speed regulators shall be designed to properly handle all loads and speeds without serious or dangerous sparking and flashing to apparatus and property.

WIRES:

All insulated wires used on this crane shall be figured on the basis of 180% greater current load, than the rated current of each motor or the combination of motors, unless otherwise specified.

All wires shall be properly fitted with lugs; wires set under set screws in hollow terminals shall not be used. All insulated wire and wiring systems on this crane shall be placed in approved iron armored conduit.

All conduit used shall be properly fastened to the crane with suitable straps and machine screws. All conduits shall be fitted with the proper junction boxes, when same are necessary to facilitate drawing the wires in or out.

A conduit shall be provided for each motor circuit. An approved flexible steel conduit shall be used for all wires on the trolley. Each motor speed regulator lead shall be protected with an approved enclosed fuse.

There shall be located in the operator's cage, a steel cabinet of approved design and pattern, to properly contain the main switch and all enclosed fuses; and to serve as a junction for all conduits and wires from regulators to motors, and for service.

This cabinet shall contain a slate panel upon which all fuse terminals and service switches shall be mounted. This cabinet shall be so constructed that all wiring connections to terminals shall be made on the back of the panel and be readily accessible at all times. This cabinet shall be so constructed that the fuses and service switch shall be readily accessible.

The constructor shall submit a sketch for approval, setting forth his method of constructing and installation of this cabinet.

The main switch shall be of ample capacity to control the total current of 600 volts and D.P.Q.B.

All insulated wires shall be double braid, approved rubber insulation and not smaller than #12 B. & S. gauge. All bridge collector wires shall not be less than #4 B. &. S. gauge, hard drawn copper wire. The collectors shall be so designed that sparking wires shall be installed so as to be at least four inches from the crane structure at their nearest point.

All appartus, wiring and fittings shall be of an approved type and subject to the rules of the National Board of Fire Underwriters and the Chicago Fire Department. All circuits shall be complete on the two wire systems, both sides testing clear from crane and structure. All insulation shall be of a fireproof nature and shall be impervious to moisture.

When bare wires are used, the use of two distinct insulations is recommended, when same is possible. The installation of wires, conduits, motors and regulators shall be done in a neat and workmanlike manner.

PAINT:

The structure parts shall have at least two coats of paint and all bright parts properly protected during shipment.

ERECTION:

This crane shall be delivered, erected and made ready for use on the crane runway in the Substation by the Chicago Railways.

INSPECTION:

This constructor is to give the Chief Engineer of the Work and the Engineer in Charge all facilities for the inspection of this crane during construction and erection. If in the opinion of the Chief Engineer of the Work or the Engineer in Charge, any work or material in connection with the crane is not in accordance with this specification, he may order the constructor to rectify the defective part or parts.

TESTS:

After crane is erected in place, it shall be subjected to a test which must be satisfactory to the Chief Engineer of the Work and the Engineer in Charge, before final payment can be made. At this test there must be present at least one representative of the constructor and the Chief Engineer of the Work and the Engineer in Charge, or their duly authorized representatives.

GUARANTEE:

This constructor shall guarantee to replace and rectify any parts of this crane which may prove faulty or defective within one (1) year from date of acceptance.

DIVISION I.

MONTHLY REPORT OF MATERIAL AND LABOR REQUIRED

FOR THE INSTALLATION OF ELECTRICAL APPARATUS.

LOCATION.

GRAND AVENUE AND 40th, AVENUE.

ENGINEER'S MONTHLY ESTIMATE.

June, 1909.

MATERIAL PLACED

Temporary store-room for storing electrical material, 15' x 20' x 8'	
Lumber, second hand, pine D.o.S.	1440 B. F.
Lumber, new pine D.1.S.	250 B. F.
" " " D.o.S.	1200 B. F.
Matched new pine	900 B. F.
Hardware	
8" hinges	1 pr.
Door latch 8" iron	1 set.
6" hasp	1 pc.
Brass Yale padlock and chain	1 pc.
Window sash, second hand	
2-1¾" x 53¾" x 58½"	2 pc.
12-12" x 18" common glass	
2-1¾" x 40" x 47½"	2 pc.
6-12" x 22" common glass	
Tar paper	100 #

Labor spent to erect this building.	
Foreman	28 hrs.
Carpenter	73 hrs.
Carpenter helper	48 hrs.
Labor spent to move in materials	
Electrician helper	16 hrs.
Laborers	32 hrs.

ENGINEER'S MONTHLY ESTIMATE.

July, 1909.

MATERIAL PLACED.

Labor spent placing ground wires, etc.	
Foreman electrician	52 hrs.
Electricians	184 "
3/4" Galvanized conduit	20 ft.
1" " "	70 "
350,000 circular mill cable for grounds	225 "
Large size Junction Box	3 pcs.
Special bolts in forms 96 pcs.	50 lbs.
6.3' of 6" Standard Channel	50 "
Labor at machine shop on Junction Boxes	
Machinists	9 hrs.
" helpers	18 "

ENGINEER'S REPORT FOR THE MONTH.

August, 1909.

The conduit was placed for the three units which are to be installed.

The high tension 2" copper is being put in readiness for the bus compartments.

The cast iron switch board brackets were installed.

ENGINEER'S MONTHLY ESTIMATE.

August, 1909.

MATERIAL ON GROUND

Galviduct.	
36 pcs. 10' X 1¼"	360'
32 " 10' X 1"	320'
Cast Iron Brackets for Feeder Rack Supports.	20 pcs.
Consignment of Alberine Stone on Ground.	
Charcoal.	11 bags

ENGINEER'S MONTHLY ESTIMATE.

August 1909.

MATERIAL PLACED

Galviduct 1¼"	660'
" 1 "	1000'
" ¾ "	280'
500,000 C.M. Copper Cable for grounding machines, etc.	222'
5 C.I. Switch Board Brackets 25# / bracket.	125#
Square Bolt with Hex Head 3" X ¾	20 pcs.
#16-iron Stove Pipe Wire.	50#
1¼" T. H. Bushings	100 pcs.
1 " " " "	100 "
¾ " " " "	50 "
1¼ " Lock Nuts	150 "
1 " " "	150 "
¾ " " "	75 "
Lard Oil	1 Gal.
Friction Tape	5 #
Splicing Compound	1 #
Wire Solder	10 #
Soldering Paste	2 Boxes
Packing House Cord	100 '
Extension Cord Plugs	4 pcs.
Hand Lamps with Guards	4 pcs.
Cast Iron Junction Boxes	
4" X 6" X 3"	13 pcs.

ENGINEER'S MONTHLY ESTIMATE.

August, 1909.

LABOR ON UNIT #1

Traveling Electrical Foreman	13	hrs.
Electrician Foreman on Conduit	48	"
Electricians " "	228	"
Electrician Foreman " Alberine Stone Sw. Bd.		
Electricians " " " " "	24	"
Electricians, Misc.	60	"
Electrician Foreman " H. T. Compartment	30	"
Electricians " " " "	124	"
Electrician Foreman " Sw. Bd.	2	"
Electricians " " "	8	"
Electrician Foreman on Crane	8	"
Electricians " "	24	"
Electrician Foreman " Current Transformers	4	"
Electricians " " "	16	"
Carpenters on Store-room	8	"

ENGINEER'S REPORT FOR THE MONTH

September, 1909.

The O'Day bricklayers completed the high tension, the oil switch, potential transformer compartments and the 9,000 volt cable ducts for unit #1.

The electricians place the 2" copper and 24 H.T. insulators for unit #1 in the H. T. compartments, also put the alberine stone in readiness for the bricklayers.

ENGINEER'S MONTHLY ESTIMATE

September, 1909.

MATERIAL ON GROUND

Consignment of several
boxes of G. E. Machinery.

Storage Battery

Consignment of copper on
ground most of which is bent
in shape.

Case Mnfg. Co.
25 ton Crane.

ENGINEER'S MONTHLY ESTIMATE

September, 1909.

MATERIAL PLACED

Contract.

Rome Brass & Copper Co.

H. T. Compartment	
2" X ¼" X 197' copper.	277#
% of contract placed	1%
125' #6 rubber covered copper wire.	125'
H. T. Compartment Material	
Lemon Sparta Brick	6474 pcs.
Alberine Stone	463 sq. ft.
21" X 2" X264' 2"	
% of contract placed	10%
H. T. insulators	18 pcs.
Cement	6½ bbls.
Lime	6½ "
Lumber for high tension switch	
1½" X 2" S4S finished oak	6½ B. F.
Oil switch compartment for unit #1.	
Green Quoins	128 pcs.
" Stretchers	235 "
White Quoins	22 "
" Stretchers.	186 "
Pot. Transfomer Compartment for unit #1	
Green Quoins	64 pcs.
" Stretchers	253 "
White Quoins	10 "
" Stretchers	179 "
Lime	1 bbl.
Cement	1 "
Oil sw. anchor rods	
6' X ¾" iron	9 pcs.
66" X ¾" "	9 "
Hex nuts 1¼"	14 "
Pot. Transfomer Compartments	
Angle Iron	
5' X 2½" X ¼"	20½ lbs.

ENGINEER'S MONTHLY ESTIMATE

September, 1909.

MATERIAL PLACED

Alberine Stone $1\frac{1}{4}$" X24" X 116"	19 1/3 sq. Ft.
28 pcs. Cap Screws 3/8 X $2\frac{1}{2}$" Hex Head	28 pcs.
56 washers 3/8"	56 "
Anchor Bolts $\frac{1}{2}$" X $7\frac{1}{2}$"	6 "
Alberine Stone for oil switch compartment 2 pcs. $1\frac{1}{2}$" x 24" X6'$4\frac{1}{4}$"	25 sq. ft.
Conduit for H. T. Cable Duct feet, tile conduit	105 ft.
Cement	6 bags

ENGINEER'S MONTHLY ESTIMATE.

Septemeber, 1909.

LABOR ON UNIT #1

Electrician Foreman on High Tension Copper	8	hrs.
Electricinas " " " "	16	"
Electricians, on Misc.	49	"
Material Clerk	32	"
Electrician Foreman on A. C. L. T. Copper	8	"
Electricians " " " " " "	168	"
Electrician Foreman H.T. Compartment	21	"
Electricians on H. T. Compartment	232	"
Electrician Apprentice on H. T. Compartment	33	"
Electrician Foreman " Positive Bus	64	"
Electricians " " "	4	"
Electricians " Negative "	48	"
Electricians on Oil Switch	96	"
Electricians on Switch Board Channel Iron	8	"
Machinists on rigging temporary machinery	16	"
Carpenters on store-room	24	"
Carpenters on forms and racks	72	"
O'Day brick layer H.T. Compartment, Foreman	40	"
" " " " " "	796	"
" " " " " " Helper	532	"
" " " " " " Apprentice	32	"
" " " Pot. Transformer Compartment	16	"
" " " Helper, Pot. Transf. Compt.	16	"
Labor Foreman	24	"
Labor	290	"
Work-cars	12	"
Teams	24	"

ENGINEER'S REPORT FOR THE MONTH

October, 1909.

The 25 ton case crane was placed by the steel erectors and the motors were wired by the elctricians.

The sole plates were layed for units 1, 2 and 3, and Units 1 and 2 were erected by the riggers.

One blower fan is in place and the panels for same are being installed at the present time.

The carpenters placed the ash sill for the switch-board and made the forms for the sole plates.

The electricians installed most of the brackets for the D. C. bus, several switch-board supports, channel iron for same, a rotary panel, pair of oil switch and battery panels, brushes on the A. C. and D. C. side of the unit #1, two field rheostats, storage battery consisting of 55 cells, oil switch and potential transformers for unit #1 and are now working on the alternating current low tension copper.

The O'Day brick layers completed the high tension compartment in the high tension room and also the oil switch and potential transformer compartment for units 2 and 3.

The Railway brick-layers layed the tile conduit line in basement of sub-station for out going feeders.

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

MATERIAL PLACED

25 ton case crane	1 pc.
½" conduit	10 ft.
1¼" conduit	30 "
1" conduit	10 "
#8 single conductor rubber covered copper wire	112 "
#6 single conductor rubber covered copper wire	138 "
2/0 trolley wire	93 "
Trolley clinch ears 12"	5 pcs.
Brooklands	2 pcs.
Bolts 6" X ½" hex head	10 "
Lumber, oak S4S 5 pcs. 3" x 3" X 8"	1 B. F.
Barn Hangers	5 pcs.
Iron for 9000 volt cable supports 3 pcs. 1½" x 3/8 X 26"	12#
Channel Iron for switch board supports 63' x 6" X .44" 13#/ft.	820#
Bolts 3" X ¾" hex head	20 pcs.
Nuts 1⅛"	20 "
Fibre Washers, 5 pcs. 6" X 6" X 3/8"	1½ sq. ft.
¾" round fibre washers	20 pcs.
Lumber, ash for switch board sill S4S 50' X 3" X 6"	75 B. F.
Grouting sole plates, units 1, 2 and 3 Cement	36 Bags
Rough Pine switch board sill 100' X8"X1"	670 B. F.
Material for rotary 1 and 2	
Steel Anchor Bolts 3"x8' 6" 16 pcs.	3270 #
" " " 2" x 4'5" 8 "	377 #
3" hex nuts	16 pcs.
3" sq. nuts	16 "
2" hex nuts	8 "
2" sq. nuts	8 "
Washers for 3" bolts 5"x½"	16 "
Cast Iron Anchor plates 8 pcs.	1248 #
Washers for 2" bolts C. I. 8 pcs.	728 #
Oil switch compartments for unit 2 and 3	
Green Quoins	256 pcs.
Green Stretchers	470 "
White Quoins	44 "
White Stretchers	372 "
Anchor rods	
6'¾" iron	54 #
66"x¾" iron	78 #
Hex nuts 1¼"	28 pcs.

ENGINEER'S MONTHLY ESTIMATE

October, 1909.

MATERIAL PLACED	
Channel Iron, unit #1 oil switch	
6" x.44" x17' 8"	230 #
Angle Iron, unit #1 oil switch	
9' 8" x1½" x1/8"	12.5 #
Potential Transformer Compartments for units 2 and 3	
Green Quoins	128 pcs.
Green Stretchers	506 "
White Quoins	20 "
White Stretchers	358 "
Lime	2 bbls.
Cement	2 "
Angle Iron 10' x2½" x¼"	41 #
Cap Screws 3/8" x 2½" hex head	56 pcs.
½" washers	112 pcs.
Anchor Bolts ½" x 7½"	12 "
High Tension Compartment	
Lemon Sparta Bricks for units 2 and 3 above fourth layer of alberine stone.	5000 "
Alberine stone 21" x 2" x 83'	145 sq. ft.
" " placed to date	80%
Rome Brass & Copper Co.	
Copper 2" x ¼" x 30'	56 lbs.
Copper placed to date	10%
Cement	5 bbls.
Lime	5 "
Bank Sand	3 cu. yds.
High tension porcelain insulators 9½" x 4"	6 pcs.
Cap Screws 3/8" x 2½"	72 "
Lumber for high tension switches (Units 2 and 3) Finished oak 1½" x 2"	15 B. F.

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

LABOR ON UNIT #1

Riggers on Bearing and Rotary	319	hrs.
Material Clerk	128	"
Steel Erecter Foremanon Crane	26	"
Steel Erecters on Crane	358	"
O'Day Brick Layer Foreman on H.T. Compt.	82	"
" " " " " "	344	"
" " " Helper " " "	300	"
" " " Apprentice" " "	40	"
Painters	16	"
Work Car and Crew	64	"
Electrician Foreman on Wiring	2	"
Electricians " "	24	"
Electrician Foreman on BlowerFans	1	"
Electricians " " "	24	"

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

LABOR ON UNIT #1

Electrician Foreman on Crane Wiring	36	hrs.
Electricians " " "	224	"
Electrician Foreman " D. C. Bus	2	"
Electricians " " " "	36	"
Electrician Foreman on Misc.	45	"
Electricians " "	432	"
Electrician Foreman on Storage Battery	9	"
Electricians " " "	56	"
Electrician Foreman on Oil Switches	9	"
Electricians " " "	88	"
Electrician Foreman on placing Unit #1 Arm.	10	"
Electricians " " " " "	59	"
Electrician Foreman on End Play Mechanism	3	"
Electricians " " " "	24	"
Electrician Foreman on Field Bearings	2	"
Electricians " " "	8	"
Electrician Foreman on Brush Holders	16	"
Electricians " " "	208	"
Electrician Foreman A.C.L.T. Bus	15	"
Electricians on " " " " "	196	"
Electrician Foreman on Switch Board Support	4	"
Electricians " " " "	64	"
Electrician Foreman on Reactance Copper	5	"
Electricians " " "	28	"
Electrician Foreman on Current Transformers	1	"
Electricians " " "	16	"
Electrician Foreman on Battery Field Rheostat	3	"
Electricians " " " "	32	"
Carpenters on Forms	28	"
Carpenters helpers on Forms	8	"
Carpenters on Switch Board Sill	60	"
Carpenter helper on Switch Board Sill	28	"
Machinists on Sole Plates	140	"
Machinist Helpers on Sole Plates	36	"
Labor	144	"
Machinists on Crane	40	"
Machinists on Blower Fan	24	"
Machinists Helpers on Blower Fan	24	"
Machinists on Armature and Bearing Setting	80	"
Machinists Helpers " " " "	16	"
Riggers on Crane	112	"
" "Hauling Machinery	232	"

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

LABOR ON UNIT #2

Electrician Foreman on Brush-holders	2	hrs.
Electricians " " "	32	"
Electrician Foreman on Oil Switch	6	"
Electricians " " "	56	"
Electrician Foreman on Storage Battery	1	"
Electricians " " "	16	"
Electrician Foreman on Unit #2	2	"
Electricians " " "	8	"
Electrician onPotential Transformers, Foreman	2	"
Electrician " " "	16	"
Electricians on Misc.	32	"
Riggers	288	"
Machinists on Unit #2	103	"
Machinist Helpers on Unit #2	58	"
Machinists Foreman on Sole Plates	20	"
Machinists " " "	56	"
Machinists Helpers " " "	16	"
O'Day Brick Layer on Oil Switch Compartment	4	"
" " " Help. on Oil Switch Compt.	4	"
" " " Ap. " " " "	8	"
Material Clerk	48	"
Labor	16	"
Carpenter on Forms	28	"
Carpenter Helper on Forms	20	"
Carpenters on Switch Board Sill	8	"
Work Cars on Bearing Delivery	40	"

ENGINEER'S MONTHLY ESTIMATE.

October, 1909.

LABOR ON UNIT #3

Electrician Foreman on D. C. Cooper	1 hr.
Electricians " " " "	16 "
Electrician Foreman on Switch Board	3 "
Electricians " " "	24 "
Electrician Fore. on Potential Transformers	1 "
Electricians " " "	4 "
Electrician Foreman on Oil Switch	4 "
Electricians " " "	36 "
Electrician Foreman on A.C.L.T. Bus Copper	1 "
Electricians " " " " " " "	68 "
Electrician Foreman on H. T. Compartment	2 "
Electricians " " " "	16 "
Electrician Foreman on Speed Limit Device	1 "
Electricians " " " "	8 "
Electrician Foreman on Blower Fan	1 "
Electricians " " "	8 "
Electrician on Misc.	16 "
Material Clerk	8 "
O'Day Brick Layer on Oil Switch Compartment	66 "
" " " Hp." " " "	52 "
" " " Ap." " " "	24 "
Carpenter on Sole Plate	24 "
" Hp. " " "	16 "
Labor " " "	12 "
Machinists " " "	60 "
Machinist Hp. " "	24 "
Machinits on Feeder Brackets	16 "
Machinists on Blower Fan	28 "
Machinist Helpers on Blower Fan	12 "
Labor on Misc.	24 "

ENGINEER'S MONTHLY REPORT.

November, 1909.

Unit #1 was turned over November, 16th,. It is now operated from six to ten A. M. and from four to twelve P. M.

The 55 cell storage battery was charged for the first time on November, 12th., the electricians completed the placing of the alternating current low tension and D. C. copper but same was not polished. The ten inch negative copper bus has been installed. Most of the G. E. apparatus for unit #2 is in readiness and the electricians are now placing the copper for same. The electricians also placed 16 feet of brackets, alberine stone behind the switch board, battery and field rheostats for units 1 and 2, 5000 ampere shunt for testing purposes, oil switches and potential transformers for units 1 and 2 complete, panels for both units, panels for three blower fans and several feeder panels, 3 of which were brought from Lill Avenue and 4 from Blue Island Avenue sub stations. The Edison company pulled in two 9000 volt cables. The switch board platforms were placed for units #1 and #2 and the crane is now being painted. The machinists are now installing the last two blower fans.

The G. E. contract is now complete for Units 1 and 2.

ENGINEER'S MONTHLY ESTIMATE

November, 1909.

MATERIAL PLACED

Unit #1	
Rome Brass & Copper Co.,	
Alternating current low tension bars	
115' x 3" x 4"	2060 #
D. C. Copper 263' x 5" x ¼"	1257 #
Negative Bus Copper 120' x 10" x ¼"	1150 #
Total	4467 #
Contract for unit #2 copper placed to date	60%
Alberine stone behind switchboard	
46' x 1' x 1½"	46 sq. ft.
per cent placed to date	95%
G. E. Contract for two units placed to date	100%
Bolts and Nuts for Bus Bars	
Cap Screws hex head 3/8" x 1"	120 pcs.
" " " " 3/8" x ½"	34 "
" " " " 3/8" x 2"	232 "
" " " " 3/8" x 3½"	72 "
" " " " 2" x ½ "	160 "
" " " " 1" x ½ "	24 "
" " " " 2½ " x ½ "	16 "
" " " " 2¾ " x ½ "	16 "
Washers 3/8"	916 "
Washers ½"	435 "
Hex nuts 3/8"	460 "
" " ½"	220 "
Angle Iron for battery rheostats supports	
2" x 2½" x ¼" 2 pcs. 13 ft. long	92½ #
Bolts 2" x ½" hex head	16 pcs.
Nuts 1"	16 "
Cast Iron Brackets for feeder support	
16 pcs. @50 # each	800 #
Channel Iron 5" x 2" x 78'	900 #
Bolts for brackets ½" x1½" sq. head	64 pcs.
" " channel iron ½" x 1½" hex head	32 "
Nuts 1" sq.	32 "
Storage Battery Material	
Conduit 1¼"	10 ft.
" ½"	5 "
Junction Box 3" x 8" x 6"	1 pcs.
1 Horse Syringe	1 pc.
Battery connecting bolts	60 pcs.
Thermometer	1 pc.
Specific Gravity Meter	1 pc.
Bracket for D. C. Copper bus (cast iron)	1 pc.
For bare ground cables	
Black Enamel 1¼" conduit	60 ft.
Cast Brass pipe stands, 6 pcs.	25 #
Rubber covered 2,000,000 c.m.	
equalizer cable for unit #1	15 ft.

ENGINEER'S MONTHLY ESTIMATE

November, 1909.

MATERIAL PLACED

Cast Brass Equalizer lug for unit #1	1 pc.
5000 ampere shunt	1 "
Porcelain insulators for potential transformer leads for units #1 and #2	10 pcs.
Channel Iron for unit #2 oil switch 6" x.44" x 17'8"	230 #
Angle iron for unit #2 oil switch and potential transformer doors	
2 pcs. 2" x 2" x 7'	45 #
2 " 2" x 2" x 9'	58 #
Porcelain floor insulators for feeders	7 pcs.
Yellow pine feeder insulators	7 "
Alternating current low tension	
3" bus connectors for unit #1 cast brass, 8# per pair	6 pr.
Material for blower panel	
1" conduit	2½ ft.
6" channel iron 9'6" long	123½ #
Pine 52" x 6" x2¼"	5 B. F.
Copper Wire	
Rubber 3/64" B&S wire #12	100 ft.
" " " " # 8	300 "
" " " " #10	250 "
" 1/16" " " # 4	140 "
" 3/64" " " #4/10	115 "
" " " " 2/10	272 "
" " " " 3/8	142 "
" " " " 2 cable	200 "
" " " " 4 "	100 "
" " " " 3/10 cable	462 "
Platforms for units #1 and #2	
Hard Dressed Maple	70 B. F.
Rubber Tape	8 #
Friction Tape	10 #
Gasoline	50 Gal.
Stick Solder	50 #
String "	15 #
Soldering paste	10 bxs.
Woodman's paint	5 gal.
Alcohol	1 "
Empire Cloth Tape	5 #

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

LABOR ON UNIT #1.

Electrician Foreman on Pot. Transformer	2	hrs.
Electricians " " "	24	"
Electrician Foreman " Field & Battery Rheo.	9	"
Electricians " " " " "	160	"
Electrician Foreman on Equalizer & D.C. Leads	4	"
Electricians " " " " " "	88	"
Electrician Foreman on Switch Board Wiring	21	"
Electricians " " " "	300	"
Electrician Foreman on Battery Wiring	3	"
Electricians " " "	32	"
Electrician Foreman on Blower Fan	2	"
Electricians " " "	24	"
Electrician Foreman on A.C.L.T. Bus	20	"
Electricians " " " " " "	256	"
Electrician Foreman on H. T. Tubing	7	"
Electricians " " " "	136	"
Electrician Foreman on Feeder Brackets	7	"
Electricians " " "	64	"
Electrician Foreman on Misc.	23	"
Electricians " "	188	"
Electrician Foreman on D.C. Copper	19	"
Electricians " " " "	336	"
Electrician Foreman on Current Transformers	1	"
Electricians " " "	16	"
Electrician Foreman on Rotary Brushes	2	"
Electricians " " "	16	"
Electrician Foreman on Oil Switch	7	"
Electricians " " "	20	"
Electrician Foreman on Feeder Panels	13	"
Electricians " " "	135	"
Electrician Foreman on Feeder Cables	3	"
Electricians " " "	64	"
Electrician Foreman End Play Mechanisms	1	"
Electricians " " "	32	"
Electrician Foreman on Reactance	1	"
Electricians " "	8	"
Machinists on Bearings	8	"
Machinists Helpers on Bearings	8	"
Rigger Foreman on Unit #1	8	"
Riggers on " "	60	"
Carpenters on Switch Board Platform	48	"
Steam Fitters	12	"
Labor Foreman	8	"
Labor	92	"
Material Clerk	80	"
Work Car and Crew	16	"

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

LABOR ON UNIT #2

Electrician Foreman on A.C.L.T. Bus	75	hrs.
Electricians " " " " "	188	"
Electrician Foreman on Misc. Unit #2	10	"
Electricians " "	136	"
Electrician Foreman on Feeder Panels	1	"
Electricians " " "	24	"
Electrician Foreman on Switch-board Wiring	11	"
Electricians " " " "	168	"
Electrician Foreman on Feeder Brackets	5	"
Electricians " " "	88	"
Electrician Foreman on Negative Copper & Cables	9	"
Electricians " " " " "	152	"
Electrician Foreman on Pot. Transformers	4	"
Electricians " " "	48	"
Electrician Foreman on Misc.		
Electricians " "	72	"
Electrician Foreman on Oil Switch	3	"
Electricians " " "	56	"
Electrician Foreman on D.C. Copper	3	"
Electricians " " " "	56	"
Electrician Foreman on Transformer	3	"
Electricians " "	28	"
Electrician Foreman on Unit #2 Brushes	4	"
Electricians " " " "	80	"
Electrician Foreman on Current Trasformer	3	"
Electricians " " "	108	"
Electrician Foreman on H.T. Tubing	5	"
Electricians " " " "	116	"
Electrician Foreman Field Rheostat	1	"
Electricians " "	32	"
Electrician Foreman on Equalizer Cable	3	"
Electricians " " "	40	"
Electrician Foreman on Storage Battery		
Electricians " " "	8	"
Electrician Foreman on Blower Fan	1	"
Electricians " " "	16	"
Painters on Crane	32	"
Painters on Blower Fan	8	"
Riggers	40	"
Machinists on Blower Fan	16	"
Carpenters on Platform	60	"
Labor	132	"
Material Clerk	44	"
Work Car and Crew	85	"

ENGINEER'S MONTHLY ESTIMATE.

November, 1909.

LABOR ON UNIT #3

Electrician Foreman on Blower Fan	1	hr.
Electricians " " "	16	"
Electrician Foreman on D.C. Bus	1	"
Electricians " " " "	16	"
Electrician Foreman on Field Rheostat	1	"
Electricians " " "	16	"
Electrician Foreman on Rotary Panel	1	"
Electricians " " "	16	"
Electrician Foreman on Misc.	1	"
Electricians " "	16	"
Material Clerk	16	"
Labor	32	"
O'Day Brick Layer on Oil Switch	12	"
" " " " " " (Apprentice)	4	"

ENGINEER'S MONTHLY REPORT.

December,1909.

Most of the electrical work was completed and apparatus placed for unit #2 and on Saturday, December, 18th, unit #2 was turned over.

The G. E. Company contract for unit #2 is now complete.

One 2000 ampere feeder panel was brought from Van Buren St. sub-station and another from Blue Island Ave. Also six new 2000 ampere feeder panels were installed, making a total of 15 panels.

Unit #3 has just arrived but the transformers and reactances have not been delivered as yet. The machinists have completed the placing of the ten horse power National Brake and Electric Company 's air compressor and the electricians have done the wiring for same.

The 25 ton crane was given a coat of builder's gray paint and the blower fans two coats of ivory drop black.

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

MATERIAL PLACED

Unit #2.

Detroit Brass & Copper Co.	
Alternating current low tension copper, 3" x ¼" x 715'	2090 #
Alternating current low tension copper, 5" x ¼" X 53.5'	243 #
Negative bus 3 pcs. 5" x ¼" x 22'	320 #
Positive bus 4 pcs. 5" x ¼" x 40'	780 #
Equalizer bus 3 pcs. 5" x ¼" x 48'	700 #
Total	4133 #
Per cent of copper placed for unit #2	100 %
Bolts and nuts for A. C. L. T. bus bars.	
Cap Screws, hex head 3/8" x 1"	60 pcs.
" " " " 3/8" x ½"	17 "
" " " " 3/8" x 2"	116 "
" " " " 3/8" x 3½"	36 "
" " " " 1/2" x 2"	80 "
" " " " 1/2" x 1"	12 "
" " " " 2½ " x ½"	8 "
" " " " 2¾ " x ½ "	8 "
Washers 3/8"	458 "
" 1/2"	218 "
Hex nuts, 3/8"	230 "
" " 1/2"	110 "
Bolts and nuts for D. C. Copper	
Caps screws 3" x ½" hex head	16 "
Hex nuts ½"	16 "
Washers ½"	16 "
Bolts and nuts equalizer bus	
½" x 2" hex head	12 "
½" hex nuts	12 "
½" washers	12 "
A.C.L.T. cast brass bus lamps weight 8# per pair	6 pr.
Iron for current transformer supports 2" x 3/8" x 10'	25 #
2,000,000 circular mill rubber covered equalizer cable	15'
Cast brass slugs for equalizer cable.	1 pc.
Nordyke Equalizer cable clamp (C.I.)	1 "
Lag screws 6" x 3/8"	2 "
Fibre spool insulator	1 "
5000 ampere shunt	1 "
1¼" eneamel conduit for bare copper ground cable, 12 pcs. 10' each for units 1 and 2.	120 '
Cast Brass pipe stands for ground cables 4# each.	12 pcs.

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

MATERIAL PLACED

Alberine stone for ground cable 42" x 10" x 2"	3 pcs.
Cast Iron brackets for D. C. copper bus 1 pc. 45#	45 #
Bolts for bracket ½" x 1½" sq. head	4 pcs.
G. E. 2000 ampere 600 volts feeder panel	6 "
For oil switch mechanism, units 1 and 2 junction boxes 3" wide x 2" high (C.I.)	4 pcs.
Yellow pine feeder braces	4 pcs.
Porcelain floor insulators for 1,000,000 C. M. cable	6 pcs.
Nordyke feeder cable clamps	22 "
Fibre spools for same	22 "
Cap screws, hex head 6" x 3/8"	44 "
Seth Thomas Clock	1 "
Lumber for four switch board platforms 2" x4" yellow pine, rough	31 B. F.
3" x 1" oak dressed	3.7 B. F.
1/4round	16 B. F.
D. M. and B. Maple 1" thick	64 B. F.
G. E. electrolytic lightning arrester	6 sets
G. E. 3 to 30 ampere porcelain fuse blocks	6 pcs.
G. E. 30 ampere 600 volt fuse	6 pcs.
#6 rubber covered stranded copper wire	24 ft.
G. E. contract for unit#2 completed	100 %
Lumber as placed in channel iron for Nordyke feeder support (S4S) 5" x 5" x 78'	163 B. F.
Copper wire for unit #2	
Rubber 3/64" B. & S. wire #12	100 ft.
" " " " " # 8	150 ft.
" " " " " #10	125 ft.
" 7/16" " " " " # 4	70 ft.
" 3/64" " " " "4/#10	165 ft.
" " " " "2/#10	136 ft.
" " " " " "3/# 8	100 ft.
" " " " " "3/#10	300 ft.
" " " " " "#2 cable	100 ft.
" " " " " "#4 "	50 ft.
Friction tape	10 #
Rubber tape	5 #
Solder	25 #
Empire cloth	5 #
Gasoline	1 gal.
Blower extension nozzles 3 pcs. #10 sheet iron	170 #
Bolts for blower, sq. head 4" x½"	36 pcs.
Slate panel for air compressor, etc. 28" x 16" x 1 1/16"	1 pc.
Iron supports 1" x ¼" x 3½'	3 #
25 amperes 600 volt quick brake switch	6 pcs.

December, 1909.

MATERIAL PLACED

Slate panel for end play mechanism 45" x 16" x 1 1/16"	1 pc.
25 ampere 600 volt quick brake switch	6 pcs.
10 ampere fuse	6 pcs.
Portable weston 0-750 volt meter	1 pc.
Painting blower fans 2 coats	
Ivory drop black 15 #	15 #
Turpentine	1 gal.
Japan	½ "
Painting crane, 1 coat builder's gray	7 "
Painting feeder brackets,builder's gray	8 "
Operator's finished oak desk 36" x 40" x 30"	1 pc.
Oak dressed and finished desk for office with six drawers, 4' x 30" x 27"	1 pc.
Finished oak chairs	2 pcs.
(National Brake & Electric Co.	
(10 H. P. air compressor, type D.D.4.	1 pc.
(Type A. air compressor govenor	1 pc.
(Air gauge 5# to 150#	1 pc.
(Cylinder tanks 5' 5" x 18"	2 pcs.
I beams 6' x 8" x ¼"	108 #
2" x ½" sq. head bolts	4 pcs.
Iron rings ½" x 2 " x 24"	2 pcs.
I beams 2 pcs. 5" x 6' 5"	126 #
Bar iron 2" x ½" x 5'2" 4 pcs.	71 #
Hex nuts ½"	8 pcs.
Bolts ½" x 1½"	32 "
Angle iron 2½" x3¼" x½" 8 pcs.	17 #
Bar Iron 12" x 3" x½" 1 pc.	5 #
1" cast iron ell	3 pcs.
1" union	1 pc.
1" insulating joint	1 pc.
1" cast iron T	1 pc.
1" x ½" C.I. T	1 pc.
½" union	2 pcs.
½" C.I. ell	8 pcs.
½" C. I. T.	6 pcs.
½" plugs	2 pcs.
1" brass pop safety valve	1 pc.
1" W. I. pipe 13' 4"	13'4"
½" " " "	103 ft.
½" C.I. ell	8 pcs.
½" C. I. T	2 pcs.
½" union	2 pcs.
½" brass globe valve	2 pcs.
½" pipe straps	9 pcs.
½" wrought iron pipe	22'2"
½" insulating joint	1 pc.
½" x ¼" T	1 pc.
½" x ¼"T	1 pc.
½" plug	1 pc.
½" ell	5 pc.

ENGINEER'S MONTHLY ESTIMATE

December, 1909.

MATERIAL PLACED

Air compressor material (continued)	
1/4" union	1 pc.
1/4" globe valve	2 pcs.
Lag screws 3" x 1/2"	2 pcs.
1/4" W. I. pipe	22 1/2 ft.
3/4" W. I. pipe	3 ft.
3/4" 45 degree ell	3 pcs.
3/4"brassglobe valve	3 pcs.
Red rubber tubing 1" for field rheostat operating rods	10 ft.

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

LABOR ON UNIT #2

Electrician Foreman	144	hrs.
Electricians on Ground Cable	32	"
" " A.C.L.T. Bus	606	"
" " Equalizer Cable and Bus	32	"
" " Blower Fan Panels	56	"
" " Switch Board	196	"
" " Negative Bus	24	"
" " Misc.	141	"
" " H.T. Tubing	132	"
" " D. C. Copper	102	"
" " Reactance	156	"
" " H. T. Compartment	32	"
" " Oil Switch	48	"
" " Unit #2	208	"
" " Feeders	56	"
" " End Play Mechanism	32	"
" " Feeder Panels	32	"
" " Switch Board Copper	8	"
" " Air Compressor	32	"
" " Operating Crane	8	"
Timekeeper	40	"
Riggers	32	"
Painters on Crane	18	"
Painters on Blower Fan	25	"
Carpenter on Feeder Brackets	60	"
Carpenter on Blower Fan Bolts	1	"
Labor	144	"
Carpenter on Temporary Machinery	8	"
Machinists on Blower Fan	40	"
Machinists on Unit #2	16	"
Machinists Helper on Unit #2	8	"
Teams	32	"
Teams American Express	8	"
Teams Brink's Express	4	"
Work Car	4	"

ENGINEER'S MONTHLY ESTIMATE.

December, 1909.

LABOR ON UNIT #3.

Electrician Foreman	64 hrs.
Electricians on ground Cables	40 "
Electricians on A.C.L.T. Bars and Braces	
Electricians on Equalizer Cables	32 "
Electricians on Switch Board	40 "
Electricians on Negative Bus	32 "
Electricians on Misc.	184 "
Electricians on Unit #3	114 "
Electricians on Feeders	96 "
Electricians on Feeder Panels	32 "
Electricians on Air Compressor	48 "
Electricians on Operating Crane	8 "
Labor	64 "
Riggers	168 "
Machinists on Unit #3	8 "
Machinist Helpers on Unit #3	8 "
Machinists on temporary Machinery	8 "
" " " " (Helpers)	8 "
" " Air Compressors	40 "
" " " " (Helpers)	24 "
Carpenters on Temporary Machinery	32 "
Carpenters " " " (Helpers)	16 "
Carpenters on Pot. Transformer Doors	8 "
Teams	9 "
Work Cars	85 "

ENGINEER'S MONTHLY REPORT.

January 1910.

Unit #3 was placed and the transformers and reactance have been delivered.

None of the copper for unit #3 has been installed as yet. No work is going on at the present time.

The steam-fitters placed the piping for the air compressor along the basement rotary walls.

The painters gave the crane a second coat of builders' gray, and also the switch board supports a coat of woodmans' black.

ENGINEER'S MONTHLY ESTIMATE.

January, 1910.

MATERIAL PLACED

Painting crane	
Builder's gray	5 gal.
Bronze	4 oz.
Potential transformer doors	
Woodmans' black paint	1 gal.
Turpentine	1 "
Linseed oil	5 "
Waste cans, enameled green 15" x 30"	2 pcs.
Nordyke feeder clamps C.I.	10 "
Fibre Spool Insulators for clamps	10 "
Lag Screws 6" x 3/8"	20 "
Yellow pine feeder braces	9 "
Porcelain floor feeder insulators for 1,000,000 C.M. cable	5 pcs.

ENGINEER'S MONTHLY ESTIMATE.

January, 1910.

LABOR ON UNIT #3

Electrician Foreman	110	hrs.
Electricians on Circuit Breaker Alarm	58	"
Electricians on Pot. Transformer	72	"
Electricians on Field Rheostat	32	"
Electricians on Operating Crane	26	"
Electricians on Feeder Cables	28	"
Electricians on Wiring	64	"
Electricians on Unit #3	72	"
Electricians on Switch Board Wiring	72	"
Electricians on Feeder Ducts	16	"
Electricians on D.C. Bus Brackets	40	"
Electricians on Misc.	60	"
Labor on General Clean Up	84	"
Riggers on Trans. Reactance and Bearings	392	"
Riggers on removing Machinery Stays	232	"
Carpenters on Bench for Electricians	8	"
Carpenters on Forms	8	"
Carpenters on Pot. Transformer Doors	28	"
Carpenters on Current Transformers	8	"
Machinists on Bearings and Rotary	56	"
Machinists on Blower Bearings	16	"
Painters on Air Compressor	8	"
Painters on Crane	72	"
Painters on Switch Board Supports	8	"
Painters on Pot. Transformer Doors	16	"
Machinists on Armature on Unit #3	48	"
Carpenters on Misc.	28	"
Steam Fitters on Air Compressor	60	"
Steam Fitter Helper on Air Compressor	20	"
Electricians on Oil Switch	64	"
Electricians on A.C. Rings	24	"
Electricians on D.C. Brushes	68	"
Electricians on D. C. Collecting Rings	16	"
Electricians on Reactance	90	"
Electricians on Transformers	16	"
Electricians on Misc.	24	"
Teams	4	"

ENGINEER'S MONTHLY REPORT.

February, 1910.

The electricians have placed the positive and negative copper bus bars and equalizing cable for unit #3.

The current transformers are being installed at the present time. Two auxiliary 2000 ampere panels have been placed. The alternating current low tension copper has not been installed as yet.

Three reactance platforms have been delivered.

The carpenters built the platforms for unit#3

ENGINEER'S MONTHLY ESTIMATE.

February, 1910.

MATERIAL PLACED

Unit #3

G. E. Contract placed to date	90%
Detroit Brass & Copper Company.	
Positive D. C. copper 5" x $\frac{1}{4}$" x 160'	778 #
Negative D. C. Copper 5" x $\frac{1}{4}$" x 66'	322 #
Total	1100 #
Bolts Hex Head, 3" x $\frac{1}{2}$"	16 pcs.
Nuts and washers $\frac{1}{2}$"	16 "
Equalizer cable, rubber covered 2,000,000 C.M.	15 ft.
Cast brass lug for cable	1 pc.
Equalizer cable clamp, cast brass	1 pc.
Fibre spool insulator for above	1 pc.
Lag screws 6" x 3/8"	2 pcs.
5000 ampere shunt	1 pc.
G. E. 2000 ampere 600 volt aux. panel	2 pcs.
Reactance platforms D. M. & B. Maple	
3 pieces 41" x 19" x 1"	17 B. F.
Dressed oak	10 B. F.
Lumber for two small platforms	
Unit #3 D. C. side , 26' x 2" x 4"	17.3 B. F.
Yellow pine, rough	
Dressed oak 26' x 3" x 1"	8.5 B. F.
D.M. & B. Maple 2 pcs. 40" x 45" x 1"	28 B. F.
Platforms on A. C. Side	
D.M. & B. Maple 2 pcs. 30" x 60" x 1"	25 B. F.
Dressed oak 2 pcs. 15' x 5" x 1"	13 B. F.

ENGINEER'S MONTHLY ESTIMATE.

February, 1910.

LABOR ON UNIT #3

Electrician Foreman	113	hrs.
Electricians on Copper for Unit #3	168	"
Electricians on Switch Board Panels	176	"
Electricians on Switch Board Wiring	104	"
Electricians on Rotary Brushes	16	"
Electricians on 5" copper	72	"
Electricians on Misc.	31	"
Electricians on Reactance	20	"
Electricians on Current Transformer Wiring	86	"
Electricians on Oil Switch	32	"
Electricians on Equalizer Cable	64	"
Electricians on End Play Mechanism	8	"
Electricians on Spped Limit Device	16	"
Carpenters on Platform	41	"
Teams	4	"

ENGINEER'S MONTHLY REPORT

March, 1910.

Unit #3 was turned over on March, 22nd,. The oil splashed from the bearings, this being due to the babbet metal that did not lie on the shaft uniformly; the metal was scrapped off and now it seems to be running in good order.

The electricians placed one set of auxiliary buses behind the switch-board and are now placing more feeder panels.

The Edison Company have not pulled in the 9,000 volt line for unit #3 as yet.

The G. E. Company have furnished greater carrying capacity over load relay coils so that when two rotarys are run on one high tension line the relays will not overheat. These coils have been placed for unit#3.

ENGINEER'S MONTHLY ESTIMATE.

March, 1910.

MATERIAL PLACED

G. E. Company contract for unit #3 completed to date	100%
Detroit Copper & Brass Company, Unit #3	
A.C.L.T. bus 3" x $\frac{1}{4}$" x 715'	2090 #
A.C.L.T. bus 5" x $\frac{1}{4}$" x 53.5'	260 #
Auxiliary bus copper 5" x $\frac{1}{4}$" x 30'	146 #
A.C.L.T. cast brass bus clamps 8#/pr.	6 pr.
Bolts and nuts for bus bars	
Cap screws, hex head 3/8" x 1"	60 pcs.
" " " " 3/8" x $\frac{1}{2}$"	17 "
" " " " 3/8" x 2"	116 "
" " " " 3/8" x $3\frac{1}{2}$"	36 "
" " " " 1/2" x 2"	80 "
" " " " 1/2" x 1"	12 "
" " " " $2\frac{1}{2}$ " x $\frac{1}{2}$"	8 "
" " " " $2\frac{1}{2}$ " x $\frac{1}{2}$"	8 "
Washers 3/8"	458 "
Hex nuts 3/8"	230 "
Washers $\frac{1}{2}$"	218 "
Hex nuts $\frac{1}{2}$"	110 "
Unit #3	
Angle iron for pot. transformer doors to swing on 7' x 2" x 3/16"	17.5 #
Iron for current transformer supports 2" x 3/8" x 10'	25.5 #
Channel iron for oil switch mechanism support, 6" x .44" x$9\frac{1}{2}$'	124 #
Channel iron 6" x .44" x50"	53 #
Angle iron for door supports 9'8" x $1\frac{1}{2}$" x 1/8"	12.5 #
Junction boxes 3" wide, 2" high	2 pcs.
Brackets for D.C. bus supports (C.I. wt. 45#)	1 pc.
Bolts for bracket, square head $\frac{1}{2}$" x $1\frac{1}{2}$"	4 pcs.
Rotary material, steel anchor bolts 3" x 8'6" 8 pieces	1635 #
Steel anchor bolts 2" x 4'5" 4 pieces	190 #
3" hex nuts	8 pcs.
3" square nuts	8 pcs.
2" hex nuts	4 pcs.
Washers for 3" bolts 5" x $\frac{1}{2}$"	8 pcs.
Washers for 2" bolts	4 pcs.
Cast iron anchor plates, 4 pieces	624 #
Cast iron anchor washers 4 pieces	364 #
Porcelain Insulators for Pot. Trans. leads	5 pcs.
Detroit Copper & Brass Company Contract placed	100%

ENGINEER'S MONTHLY ESTIMATE.

March, 1910.

LABOR ON UNIT #3

Electrician Foreman	156	hrs.
Electrician on D. C. Cable	56	"
Electricians on Switch Board Wiring	48	"
Electricians on Current Transformers	104	"
Electricians on Misc.	76	"
Electricians on Oil Switch Wiring	40	"
Electricians on H.T. Tubing	300	"
Electricians on Slate for A.CL.T. Bus	24	"
Electricians on A.C.L.T. Bus	316	"
Electricians on Transformer Contacts	56	"
Electricians on A.C.L.T. Brackets	16	"
Electricians on Field Rheostat	16	"
Electricians on End Play Mechanism	16	"
Electricians on Bearings	24	"
Electricians on Auxilliary Bus	124	"
Riggers on Bearings	48	"
Machinists on Bearings	26	"
Machinists " " (Helpers)	28	"
Electricians on Changing Over-load Relays	8	"
Electricians on Feeder Panels	24	"
Work Cars	4	"

ENGINEER'S MONTHLY REPORT.

April, 1910.

The electricians placed four new 2000 ampere, 600 volt feeder panels, the 5" auxiliary copper bus and all the lightning arresters behind the switch-board. The six cell electrolytic lightning arresters were installed for unit #3.

The cement finishers grouted up the girders about the iron support for the current transformers of unit #3.

The two oil tanks and the adjustable measure pumps were delivered by S. F. Bowser & Co., as per specifications.

Three pieces of corrugated rubber matting were delivered and placed at each of the reactance switches as an insulator.

The feeder brackets and posts upon which they are supported were painted a coat of builder's gray.

ENGINEER'S MONTHLY ESTIMATE.

April, 1910.

MATERIAL PLACED

G. E. 2000 ampere, 600 volts feeder panels	4 pcs.
Auxiliary bus copper 5" x ¼" x 11' 2 pcs.	112 #
Iron Lightning Arrester brackets 1" x ¼" x 23½"	36 #
Lightning arrester ground copper bus 1" x ¼" x 58'	54.5 #
Empire cloth	5 #
Soulder	5 #
Friction tape	5 #
Rubber tape	5 #
Grouting girder due to the placing of the current transformer iron supports. Cement	1 bag
Painting feeder brackets and posts Builder's gray	1 gal.
Rubber corrugated matting for insulating reactance switches 4' x 3'	3 pcs.
Dressed and finished oak bracket for electrolytic lightning arrester for unit #3	1 pc.
Iron brackets for above 2 pieces 1"x¼"x4'	7 #
Cap screws, hex heads 2" x 3/8"	4 pcs.
G. E. electrolytic lightning arrester	3 sets
G. E. 3 ampere to 30 ampere porcelain fuse block	3 pcs.
G. E. 30 ampere 600 volt fuse	3 pcs.
#6 rubber covered stranded copper wire	12 ft.
S. F. Bowser & Company contract Oil tanks and pumps. Tanks 35" x 28" x 41"	2 pcs.
Adjustable pumps quart, pint and half pint measure.	2 pcs.

ENGINEER'S MONTHLY ESTIMATE.

April, 1910.

LABOR ON UNIT #3

Electricians on Feeder Panels	176	hrs.
Electricians " Aux. Bus.	36	"
Electricians " Lightning Arresters	112	"
Electricians " 1" ground Bus for Lightning Arresters	24	"
Electricians on Over-load Relay	8	"
Electricians " Reactance on Unit #2	24	"
Labor, cementing up current transformer supports.	12	"
Cement Finisher cementing up current transformer supports	12	"
Cement Finisher Helpers cementing up Current Transformer Supports	12	"
Painter on Feeder Brackets	8	"
Teams removing temporary machinery used on Electrical Work	8	"
Teams delivering Bowser Oil Pumps and Tanks	4	"

ENGINEER'S MONTHLY REPORT.

May, June and July, 1910.

Two feeders, (1,000,000 C.M. cables) were pulled into the station and then connected up to the panels by the electrician.

Mc Master & Carr Supply Company delivered a #2 White Star Oil Filter, having a capacity of twenty gallons.

The Electricians placed ten lights behind the switchboard.

ENGINEER'S MONTHLY ESTIMATE.

May, June and July 1910.

MATERIAL PLACED

Materials for placing 2 feeder cables	
Friction tape	5 rolls
Soulder	5 #
Pine Spool feeder Supports	2 pcs.
Nordyke C.I. Feeder Supports.	4 pcs.
SplitOak Spools for above	4 pcs.
Lag Screws 3/8" x 2½" square head	8 pcs.
Mc Master & Carr Supply Company	
#2 White Star Oil Filter, capacity 20 gallons	1 pc.

Labor for Month, on above.

June, 23rd, 3 electricians		24 hrs.
June, 24th, 5 "		42 "
	Total	66 "

MATERIAL PLACED

Lighting behind switch-board	
½" conduit	48 ft.
½" bushings	4 pcs.
½" Lock Nuts	21 pcs.
Round Junction Box 3" x 2"	10 pcs.
G. E. 3 ampere, 650 volt Lamp Sockets	10 "
Incandescent Lamps	10 "
Rubber Covered Wire #14	50 ft.

ENGINEER'S MONTHLY REPORT.

September, 1910.

Three new feeder panels were brought from La Salle and Illinois Sts. Sub-stations and installed. One panel was used to give power to the stone crusher motor in the stone yard next to the Sub-station and the other two were used for power and light in the 48th, and North Avenue, barn .

A brick-layer and five laborers laid four ducts for the feeder cables.

The electricians placed the volt meter brackets used for the 600 volt meter.

ENGINEER'S MONTHLY ESTIMATE.

September, 1910.

MATERIAL PLACED

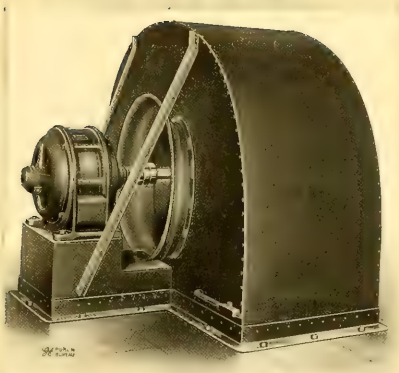
Mild Steel for volt meter supports	10 lbs.
¾" Hose Nipples	6 pcs.
G. E. Feeder Panels 600 volt, 2000 amperes	3 pcs.
Friction Tape	4 rolls
10" x 1/4" copper for extension of Sw. Bd.	95.6 lbs.
Placing four feeder ducts, each 34' long	
Tile Conduit	136 ft.
Crush Stone	½ yd.
Cement	9 bags
Bank Sand	½ yd.
1 G. E. Feeder Panel 600 volt 2000 amperes	1 pc.
Pine Insulators	4 pcs.
10 ampere fuses and fuse clips	2 pcs.
#14 rubber covered wire	40 ft.
Steel door placed on steel shelving	
Iron Hinges 6" x 8"	4 pcs.
Iron Doors 40" x 14" x .102"	14 lbs.
" " 4' x 20" x .064"	20 "
" " 4' x 32" x .064"	30 "
Angle Iron 1" x 10' 1.2 # per foot.	12 "

ENGINEER'S MONTHLY ESTIMATE.

September, 1910.

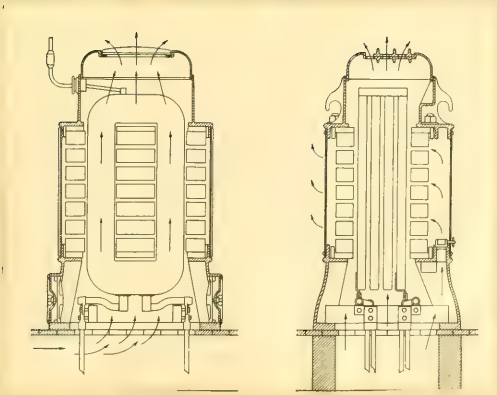
LABOR

Volt Meter Frame	
Machinists	6 hrs.
Electricians on Feeder Panels	138 hrs.
Teams	16 "
Electricians wiring volt meter	40 "
Labor on Feeder Ducts	
Brick Layers	8 hrs.
Labor	5 "
Labor on Steel Doors placed on steel Shelving	
Boiler Makers	24 hrs.
Boiler Maker Helpers	24 "



Induction Motor Driven Blower

Air Blast Reactance and Starting Switches



INSTRUCTIONS FOR THE INSTALLATION AND OPERATION OF AIR BLAST TRANSFORMERS.

Introductory:

The following instructions will serve as a guide to those installing and operating Air Blast Transformers of the General Electric Company's design.

As is generally known, transformers of this type depend upon forced air currents to carry off the heat due to the losses, and are necessarily of a different construction from oil-cooled transformers. The accompanying cross sectional view shows in a general way the method of construction and system of ventilation. It will be seen that numerous small air ducts run transversely through the laminations and vertically between the various coils. The air from the former passes out at the side and from the latter at the top of the transformer, dampers being so arranged that the amount of air in each direction can be separately regulated.

SHIPMENT AND UNPACKING.

The construction of these transformers is such that it is not necessary to do any disassembling, they are therefore always shipped completely assembled, surrounded by proper boxing. This should not be removed until a permanent shelter is available for the transformers to protect them from dirt and mechanical injury and also to prevent moisture settling on the coils which might be detrimental to the insulation. Where a crane is available, transformers should be handled entirely by it, making use of the lifting lugs which are cast on the cover. If a crane is not available and rollers must be used, they should always be placed under the skids or planks which are fastened to the base of the transformer, before shipment. These rollers should not be placed directly next to the cast iron base, for while this is amply strong to withstand strains for which it is designed, since it acts as the air chamber it is necessarily of shell construction and the strain of removing the transformer laterally should therefore be distributed over the bases by using the skids above mentioned.

LOCATION AND FOUNDATION.

The transformer being open at the top to allow the exit of air, should not be located where dust, dirt or water is liable to drop on it.

Special foundations are not necessary other than a good even floor, strong enough to support the weight of the transformer.

To provide for the admission of the proper amount of cooling

air, the transformer must be located over a chamber or duct of ample dimensions. This should always be constructed of non-combustible material, preferably brick or concrete, having smooth sides to minimize friction and eddy currents of air. Turns in this construction should be avoided and all corners should be rounded if possible. The velocity of the air should be kept low and never exceed 500 ft. per minute. Sufficient space should be allowed for the primary and secondary cable in this duct. It is also generally advisable to make the cross section large enough to admit a man, to permit cleaning from below and a close inspection of the winding and connections at the bottom of the coils.

TERMINALS AND CONNECTIONS.

The terminals may be brought out to suit the requirements of particular installations but the most convenient arrangement is to bring both primary and secondary leads out of the base and this is the practice generally followed. This gives a neat appearance to the station, doing away with the overhead wiring and at the same time all connections are readily accessible in the air duct.

The high-tension leads are usually of flexible cable fitted with union couplings and covered by hard rubber sleeves. The low-tension leads, generally requiring a large current capacity, are attached to heavy lugs into which the line connections may be made.

Complete information in regard to the various combinations of the windings and the different voltages obtainable, is to be found on the "DS Sketch," a print of which is always to be found mounted in a special diagram on each transformer.

SUPPLY OF AIR.

Air Blast Transformers require a large volume of air at a low pressure. The proper pressure required is specified on the name plates of all the transformers and the blower sets supplied will always give this pressure, or one slightly in excess, within the limits of the volume for which the fan is designed. An approximate estimate of the volume of air required can be arrived at when the efficiency is known by allowing 150 cubic feet of air per minute for each kilowatt loss in the transformer. The table on page 12 gives the cubic feet of air and pressure to be used with several different sizes of single-phase transformers. These figures apply to transformers with standard efficiencies, others may require slightly more or less air and hence will be supplied with blowers to meet the conditions of the particular case in question. It will be noted that, as the size of the transformer unit is increased the air pressure must be slightly increased but the volume required per kilowatt can be decreased. Three-phase transformers have somewhat longer air ducts than single-phase and require a slightly higher pressure. The amount of air necessary

for the three-phasetype will be the same as three single-phase transformers of one-third the capacity, but the pressure should be that required for a single-phase transformer corresponding in capacity to the three-phase transformer.

To determine whether sufficient air is passing through either the single- or three phase transformer the simplest method is to measure the temperature of the outgoing air and compare it with the temperature of the ingoing air. If there is not more than 30° C. difference the supply is usually sufficient. The best results are obtained when the temperature of the incoming air is not greater than 25° C., as the design is in general based on this value.

It is essential that clean dry air be used and the intake should be so located as to obtain this. The air chamber should be designed so as to maintain an equal pressure under each transformer.

BLOWER SETS.

The Blower-Sets may be located in any position best adapted to the station lay out. However, to avoid a lengthy air duct and waste of air pressure, it is advisable to place them as near as possible to the bank of transformers which they are cooling. The General Electric Company's Blower Sets are very strong and rigid in construction so that they require only the ordinary attention usually accorded such apparatus, such as lubricating the bearings, etc. They are not very liable to break down; however, in all but the smallest plants duplicate cooling sets should be provided so as to avoid any possibility of interruption of the service. In case of complete breakdown of the air supply the transformers cannot be safely operated at more than one-half load and even at that load for not more than an hour or two as a general thing. When transformers are operated in this manner the doors on both sides of the base should be removed so as to allow as much air as possible to be drawn up through the core and coils. Where two blowers sets are used it is best to locate one at each end of the bank of the transformers, as shown on the preceding page, rather than both at one end. Each blower is operated with a damper by means of which the flow of air may be regulated, and the blower should be shut off from the duct when not in use.

DRYING OUT AND STARTING UP.

During transportation or storage, transformers are often subjected to conditions which cause condensation of moisture on the surface of the coils as well as on the metallic surfaces. The moisture on the exposed surfaces will readily evaporate as soon as the transformers are installed in a warm dry place, except that which perhaps has settled in the small remote air ducts which is not so easily gotten rid of.

Unless this moisture is removed before throwing full voltage upon the coils it may be dangerous to the insulation. Hence, it is strongly advocated that all transformers should be thoroughly dried out before connecting them to normal line voltage. This will be a comparatively easy task as the blower sets can be run at their normal speed and will afford an efficient means for carrying off the moisture. At the same time, however, the transformer winding should be heated up to a temperature slightly above the surrounding air so as to thoroughly dry them out and force all moisture to the surface, where the air currents will carry it off.

The heating of the windings can be conveniently effected by passing a small current through them. Either D. C. or A. C. current may be used, the latter having the advantage that the desired current may be easily circulated in both primary and secondary coils by short circuiting one of the windings and applying the necessary voltage to the other, The voltage necessary to force full load current through either winding with the other short circuited, known as the impedance Voltage, varies from 1 to 4 per cent. of the full-rated voltage of that winding, depending upon the capacity, the designed voltage, and frequency of the transformer. Exact data on each particular transformer can always be had on application to the nearest district office, or to the general office, Schenectady, N. Y. However, it will only be necessary to use about three-fourths of the impedance voltage since 75 per cent. of normal current should be ample to give the required heating up of the windings. In no case should more than normal current be used in either winding. A low constant heat continued for 24 hours will accomplish much better results than a high overheating for a short time, and is much safer.

If D. C. current is used, the high tension winding is usually the only one used, as it generally has enough resistance to give sufficient heat for both windings if run in this way long enough. Under ordinary conditions the above treatment should be very thoroughly dry out the insulation of the coils, unless they have been subjected to extremely bad conditions in which case the drying out run should be prolonged to 36 hours or longer.

POLYPHASE TRANSFORMERS.

General Electric Polyphase Transformers of the shell type construction are built along the same general lines as the single-phase design, being essentially three single-phase transformers, as far as the windings are converned, but having the cores consolidated into one structure. This, as already cited under "Supply of Air" requires longer air ducts.

An objection sometimes reaised against polyphase transformers is, that the failure of one-phase throws the entire unit out of service. Three-phase transformers of shell-type construction with both primary and secondary windings delta connected can, however, be temporarily operated on two of the phases in case one phase of the winding becomes damaged. To do this, it is not

only necessary to disconnect the damaged phase windings, both primary and secondary, but to short circuit these windings on themselves. Otherwise the flux that would flow through the damaged windings would appreciably increase the losses and further damage the coils. By short circuiting the entire phase windings, however, enough ampere turns are developed with a current much less than load current, to drive back the flux.

This method of operation on two-phases with the other disabled, is not possible when either winding is "Y" connected, or in a core type transformer.

CLEANING.

As there is sometimes considerable dust in the air there is a possibility that some of the ducts in the transformer will, in the course of time, become clogged and retard the circulation of the air which may result in local overheating. This would gradually weaken the insulation and possibly result in a burncut. To prevent any liability of danger from this source, all parts of the transformers should be given a thorough cleaning once a month or more often if necessary. The cover should be removed from the top of the transformer and cleaning should be done by means of a brush and compressed air. The use of the latter at about 30-pound pressure is strongly recommended as this will remove the dust from the otherwise inaccessible ducts.

TEMPERATURE.

The temperature of standard designs when operating under normal load will not exceed 40°C. or 35°C. rise above the surrounding air, according to the guarantees to be met. Temperature measurements should be taken by the resistance method, as this is the only one that will give the true mean temperature of the coils. It is out of the question to use a thermometer, since the air blast would have such a cooling effect upon it that its readings would not be correct.

CONNECTING IN PARALLEL.

Only transformers designated by special instructions of the Company should be connected in parallel, since other transformers, even if marked for the same capacity, voltage, periodicity, may differ as to regulation, so that when connected they will not divide the load in the proper ratio, and one or more transformers may be overloaded. Care should also be taken in connecting large transformers in parallel, especially when one of the windings is of comparatively low potential, that the resistances of the joints and of the interconnecting wires, or bars, do not differ sufficiently to cause the load to divide unequally.

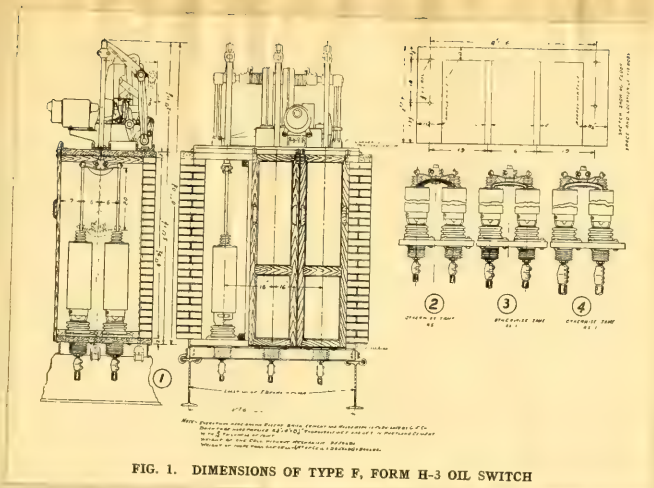


FIG. 1. DIMENSIONS OF TYPE F, FORM H-3 OIL SWITCH

FIG. 4. OIL POTS AND CONTACTS FOR 35,000 VOLT SWITCH

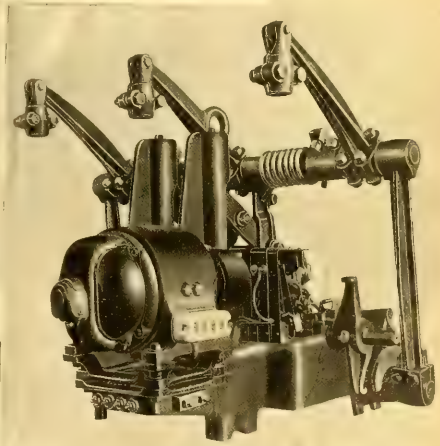


FIG. 5. OPERATING MECHANISM FOR SWITCHES OF 35,000 VOLTS OR LESS

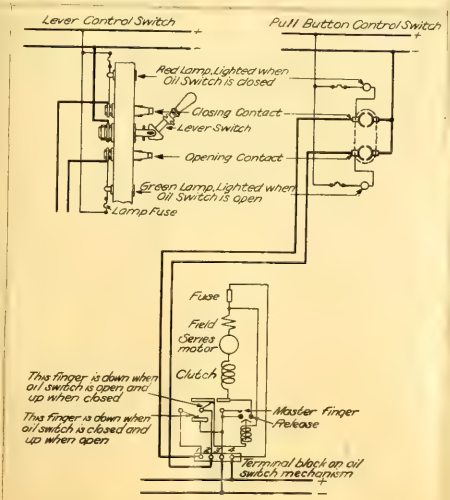

Lever Control Switch
Pull Button Control Switch
Red Lamp, Lighted when Oil Switch is closed
Closing Contact
Lever Switch
Opening Contact
Green Lamp, Lighted when Oil Switch is open
Lamp Fuse
Fuse
Field
Series motor
Clutch
This finger is down when oil switch is open and up when closed
This finger is down when oil switch is closed and up when open
Master Finger
Release
Terminal block on oil switch mechanism

FIG. 7

TYPE F, FORM H-3 OIL SWITCHES.

The following instructions as to the construction, adjustment and maintenance of Type F, Form H-3 oil switches should be carefully read and followed.

FOUNDATIONS:

Foundations are built on permanent and substantial structural steel work and concrete or similar material. "I" beams or steel anchor plates are so arranged in the foundations that tie-rods can be securely fastened to them for bolting down the channel beam which is used on top of cell as shown in Fig. 1.

CELL CONSTRUCTION:

Cells are made of brick with barriers of concrete 2¼" in thickness. When erecting a cell, the stone for supporting the oil pots and the slabs for supporting the mechanism must be placed parallel and horizontal.

Top and bottom slabs (for switches below 45,000 volts), should be so mounted that a vertical line from the centers of the holes for the wooden rods, in the upper slab will intersect, in the middle, the line connecting the centers of the holes through which pass the insulators in the lower slab. The top slab and supporting wooden frame for switches of 45,000 volts and above should be so mounted that a vertical line from the centers of the holes for the wooden rods in the upper slab will intersect, in the middle, the line connecting the centers of the holes for the contact rods in the upper side of the wooden oil vessels.

The line connecting the centers of the holes for the insulators in the lower slab must be at right angles with the back wall of the cell. This will allow the rods carrying the "U" shaped contact pieces or cross-heads to hang vertically in the proper positions. The channel beam used on the top of the cell should be securely bolted down, by means of the tie rods which extend through the cell walls to the anchor plates in the foundations. Special care should be taken to draw the channel down level, so that the lower rock shaft will not bind in its bearings.

DOORS.

Cell doors should be made of asbestos lumber panels, or equivalent, with wooden frames, and should be hinged at the top, so as to be free to swing outward should an explosion occur in the cell.

LINING UP MECHANISMS.

After the operating mechanism is placed on the top of the cell great care should be taken before bolting it down, to see that the three lever arms which carry the wooden rods, operate in a vertical line to the center of the holes in the top stone. This aligning should be done with a plumb line.

Correct alignment must be given the oil pots. This is accomplished by dropping a plumb line from the center of the hole in the upper soapstone, so that it will just clear the lower slab (used with switches of 35,000 volts or under): the vertical center lines of the oil pots should be parallel to this plumb line; adjust by using shims under the insulator supporting plates.

The wooden rod connecting the cross-head with the contact rod is made of such length that the lower end of the rod should be screwed in the clamp on the cross-head until it is flush with the lower surface of the clamp

The upper end of the rod should be screwed into the upper clamp in the same way. This will bring the contacts in the correct position at both ends of the stroke, provided the height of the cells is correct, as shown on the drawings.

Vertical adjustment of the cross-head may be obtained by removing the upper clamp from the switch lever arm and giving it one or more half-turns up or down the threaded wooden rod as required. The clamp at the lower end of rod should not be adjusted; the end of the rod should be flush with lower surface of the cross-head.

The stroke should be measured from the under side of the cross-head to the upper surface of the porcelain bushings on the top of oil pots.

On switches having contact brushes attached to the cross-heads, as shown in Fig. 1, Nos. 2, 3, and 4, the brushes should be forced down until they make full contact with the copper casting on the upper end of the oil pots. The rods should then be adjusted so that the brushes will be forced into this position when the switch is closed.

Test all brushes by placing a thin sheet of paper between brush and contact, and adjust until marks on the paper show that all of the laminations make contact.

The contact rods should clear the bottom of the oil-pots by one-eighth to one-quarter of an inch. The cross-head carrying the contact rods should clear the upper porcelain insulators by at least one-quarter of an inch when the switch is closed. The contact clamps on the bottom of the oil-vessels should be set up securely by means of the bolts and set screws. To insure good contact all oil vessels having contact surfaces for brushes (on switches exceeding 300 amperes capacity), should be carefully leveled so that the top contact surfaces for each pair of pots will be in horizontal plane.

DETAILS OF OPERATING MECHANISM:

The compression springs should need no adjustment as these springs are tested and calibrated for each individual switch. The funtion of the torsion springs on the upper rock shaft is to counterbalance the weight of the cross-heads, etc. and these springs need little, if any, adjustment. However, if they need adjusting they should be made to have sufficient initial tension so that the switch will have practically the same speed in both opening and closing. If the opening action is slow, the spring should be tightened slightly; if too fast, the spring should be relaxed.

The motors should be kept clean, commutators and brushes regularly inspected and all oil cups kept filled with a good quality of machine oil. The 70-volt motor will operate successfully on circuits of from 70 to 140 volts; the 110-volt motor, on circuits of from 90 to 180 volts, and the 220-volt motor on circuits of from 150 to 300 volts. Motors should be connected directly to the proper circuits without any resistance for starting being inserted in series.

If motors are changed from one mechanism to another (a practice not recommended), special care must be taken to have the motor shaft and worm shaft in perfect alignment so that they will run freely and smoothly. Adjust by using shims.

The mechanism should be operated a number of times with the ratchet wrench, after the switch has been set up. Great care should be taken not to operate it with the motor until the lengths of the rods have been adjusted; the links and levers, especially those of the tripping toggle, should be oiled and limbered up to work freely. The ratchet wrench provides for the free rotation of the shaft in the direction in which it is being turned.

The air gap in the magnet clutch is carefully adjusted before shipment and should not require adjustment under ordinary circumstances. In case it is necessary to reduce or increase the gap in order to obtain greater or less torque upon the cluth, this adjustment can be made by means of the nuts on the end of the worm shaft, and the position of the end-thrust ball bearing varied slightly to obtain the desired change. These nuts should be securely locked in position.

On the Form H-3 switches, the dog on the crank shaft, and the controlling finger cams, are carefully adjusted before leaving the factory so that the motor operated switch will always trip freely when the tripping toggle is relaeased, without assistance from the motor.

Outside adjustment of the cams for tripping dogs is not receommended unless the mechanism is damaged in shipment. However, the cam adjustment may be accomplished by moving the master finger cam or bending the contact finger so that the master finger (which is the outside one of the three fingers) will break contact when the crank arrives at a position slightly over center, and the end of the dog arrives at a point three-eights to one-half inch away from the roller stop of the toggle trip. The cams for operating the other two indicating fingers should be so adjusted that the one next the master finger will remain in contact when the oil switch is closed, and the other will make contact when the switch is open. The mechanism and switch parts should all be throroughly overhauled at least once a year.

GEARS.

The worm gear on all switches is shipped with the gear teeth filled with greese. Tallow should be used on this gear if more lubrication is required, or the gear case can be partially filled with heavy machine oil to lubricate the gear at all times.

The friction clutch within the gear case on the crankshaft should be oiled occasionally with a very small amount of sperm oil as other oils are liable to gum. When the cluthh is opened for inspection the springs holding the pawls should be examined to see that they are in good condition and that they hold the pawls forward so that they will engage the steel friction ring.

Should it become necessary to change the gears on a 60,000 or 45,000 volt switch mechanism, care should be taken to see that the reduction gears mesh properly and run freely; and the dogs on the main gear must be so fitted against the boss that when the crank is thrown slightly past center, the end of the dog is from three-eights to one-half inch away from the roller-stop of the trip crank. At this point the master control finger (which is the outside one of the three fingers) should release from contact by means of the cams on crank shaft, cutting out the motor. The momentum of the switch and mechanism is sufficient to carry the dog up against the roller stop, ready for the next operation, and the lever arms will make their full stroke.

The adjustment of the dogs is accomplished by filing away or by shimming up the bosses against which the dogs rest.

When the switch is being installed, the gears should be kept free from dust and dirt. If the mechanism has been exposed to dampness and dirt during installation, it should be thoroughly cleaned and oiled before it is operated.

WIRING AND CONTACTS

The accompanying diagram, Fig. 7, shows the connections of the indicating lamps, controlling switch, and cam-actuated fingers on the switch mechanism. This diagram, of course does not show the mechanical details of the magnetic release, but the toggle holding the stop against which the releasing dog is held, is released just before the contact is made by the plunger in the trip coil circuit, at the point marked "release" on the diagram.

This permits the oil switch to be set in motion under the action of the compression springs, and the switch is thrown about one inch into contact without assistance from the motor.

Then the motor engages the friction clutch and carries the switch to its complete stroke, at the same time the compression spring is being compressed ready for the next operation. The diagram shows four studs for the controlling leads on the mechanism, numbered from 1 to 4 beginning at the left. The studs on the 45,000 and 60,000 volt switches are reversed, No. 4 being on the left.

The fingers for the controlling circuits and the fingers for the indicating lamp circuit should be inspected to see that they make proper contact upon the contact plates, and they may be bent slightly with a pair of pliers if the contact is not good.

Should the controlling fingers become injured, they can be readily renewed by removing the screws from the carriers and inserting new fingers.

The stationary contacts in the bottom of the oil vessels, consist of four segments held together by means of tension springs and retaining rings. These contacts are accessible after the retaining ring is removed, by means of a long spanner-wrench.

Contact rods should be cleaned from time to time and inspected to see if the tips are burned. New rods should be examined before being used, and if bent should be straightened on a level plate with a rawhide mallet.

This Company strongly advises the inspection of contacts after opening a heavy short circuit, or at least every three months.

OIL.

Oil should be maintained in the oil vessels at the height indicated by the line on the outside of the pot; use No. 6 transil oil. The oil should be inspected after a heavy short circuit is opened, or at least every three months, when the oil should be renewed if necessary.

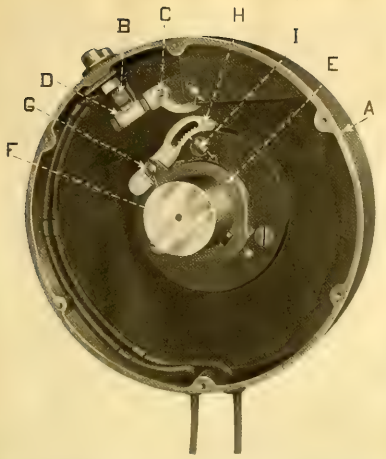


FIG. 1. SPEED LIMITING DEVICE WITH COVER REMOVED

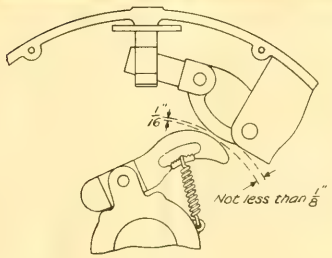


FIG. 2

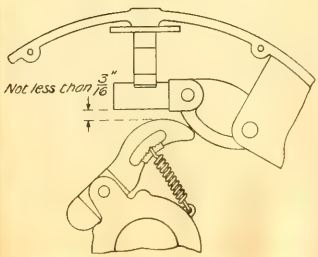


FIG. 3

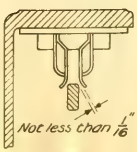


FIG. 4

ADJUSTMENT OF SPEED LIMITING DEVICES:

This gives the proper method of installing and adjusting the Speed Limiting Device, which is supplied by The General Electric Company for Rotary Converters, Motor Generator Sets, or other apparatus, to prevent excessive speeds.

The device, as shown in the illustration, Fig. 1, consists essentially of a stationary and moving part. The stationary part is a cast iron shell A bolted to the end of the bearing housing, which carries contact clips B and a specially-shaped pivoted switch C provided with blade contacts D. The rotating part consists of a ring E keyed to the shaft F and a weight H pivoted on lugs G cast in the ring. The end of the weight is pulled toward the ring by a spiral spring I fastened to the ring. When the shaft revolves the centrifugal force of the weight moves it outwards, so that at a certain speed it strikes the switch and forces the latter into the contact clips. The outward movement of the weight is controlled by the spring whose tension can be adjusted. When the switch engages in the contact clips, the low-voltage release coil on the switchboard circuit breaker of the machine is short-circuited and the circuit breaker is tripped.

In order that the device may properly operate, the following adjustments must be carefully made;

With the weight moved outwards to the maximum distance, an eighth-inch clearance shown in Fig. 2 must be allowed between the centrifugal weight and that part of the shell to which it is nearest. With the switch as far in the contacts as it will go, and with the weight at its maximum distance outwards, there must be a sixteenth of an inch clearance between the nearest point of the switch and the centrifugal weight. This clearance must be allowed in order to prevent the weight from hammering the switch after the switch has been driven into the contact clips.

With the weight moved outwards to its maximum distance, there must be a clearance of three sixteenths of an inch between the nearest point of the switch blade and the centrifugal weight, shown on Fig. 3. A one-sixteenth inch clearance must be allowed between the switch blade and the clips when the switch blade is in its extreme out position, as shown on the sectional view, Fig. 4.

The adjustments of the clearances of the switch and centrifugal weight can be obtained by finishing their respective stops (on the short end of the switch and weight respectively measured from their pivots), to the proper dimensions. If too much material has already been removed from the stop, it may be drilled and tapped for a screw or plug which can then be finished to the proper dimensions.

All of the clearances given are the minimum that are obtained when the weight is rotating.

After these clearances have been adjusted, the spring should be adjusted, if necessary, so that the centrifugal weight strikes the switch and drives the switch blade into the clips when the speed has reached the specified limit. The springs are usually adjusted so that the weight operates on the switch when the speed has risen 15 per cent, above normal. The method of spring attachment and therefore of adjustment will be clear from the Figures.

These adjustments must be made and the device tested so as to obtain proper operation, before the machine on which it is installed it put into service.

REACTANCES.

To enable the D. C. voltage to be altered by the field rheostat or automatically by compounding, which calls for a corresponding change of the A. C. voltage, a three-phase reactance coil is provided between the low tension windings of the transformer and the converter. Without such a reactance the maintenance of the same voltage at full load as at no load involves excessive leading and lagging currents and consequently excessive heating in the converter armature, unless the resistance drop from the source of constant potential is small, or the natural reactance of the circuit is unusually high.

If the converter field is weakened, a lagging current is set up which causes a drop in the reactive coil. If the field is strengthened a leading current is set up which gives a rise of voltage in the reactive coil. Under heavy lead, the series field of a compound converter tends to produce leading currents, which tendency is practically balanced by the reactance, improving the power factor of transformers, lines and generators when loaded.

The standard reactances are rated in k.v.a. equal to 15 per cent. of the Kw. rating of the accompanying converters. For instance,a 300 kw. converter is supplied with a reactance in each phase in which the full load current, 500 amperes, causes a reactive E.M.F. of 30 volts or approximately 15 per cent of the delivered E.M.F.

Thus a lagging current or component equal to 1/3 full load causes a 5 per cent, drop in the reactance coil, and a leading component of the current of the same magnitude causes a 5 per cent. boost or rise of voltage. Six-phase converters use three-phase reactances with twice as high a voltage drop at full load. The Air-blast reactances are used with air-blast transformers.

END PLAY MECHANISM.

In order to keep the commutator smooth it is necessary to have a device for shifiting the armature back and forth. This is accomplished by placing an electro magnet at the end of the shaft on the D.C. side of the Rotary; mechanically connected to the bearing. Current is sent through the coil through two carbon contacts, through a rheostat to ground.

As the armature revolves the armature shaft is attracted by the electro magnet, but as the shaft moves over about 1/2" a rod breaks the carbon contact circuit and hence the armature moves back, due to the mutual attraction of the armature and field flux and as soon as this takes place the carbon contacts come together again and the process is repeated. Across the carbon contacts is placed a condenser so as to break the arc.

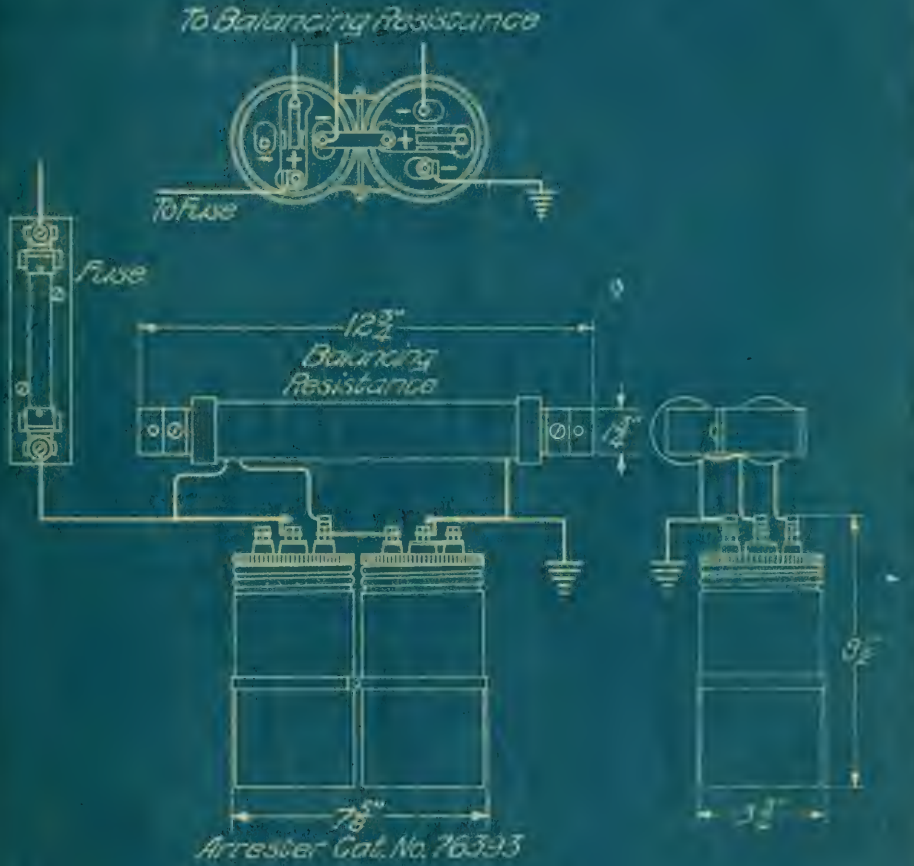
STORAGE BATTERY.

The storage battery consists of 55 cells of the chloride type included in the G. E. contract. Each cell has 6 positive and 7 negative plates, each plate having dimensions 8" X8".

The cells are connected in series through a rheostat and thence to the switch-board which is provided with charging and discharging switches. The cells are charged at about 6 amperes, 140 volts, the 140 volts being obtained by reducing the 600 volts through the rheostat. The cells are charged as a rule twice a week for sixteen hours each time. After the cells have been charged the specific gravity should be about 1200 and the voltage 110. When the voltage begins to drop below 110 it is necessary to recharge. These batteries are only used for the purpose of operating the oil switch motors, lighting the instruments and pilot oil switch lights. All the lights require about 2 amperes, but it takes 40 amperes to throw the oil switch motor.

The battery rests on concrete compartments as shown on picture. All metal must be well painted to keep it from corroding.

Connections of Type GE Form A 600 Volt Aluminum Lightning Arrester
For D.C. Railway Circuits, Station Service



Checked
19 May 1909

Drawn D. B. Rushmore, E.T.F.
Engineering Dept.
General Electric Company
May 1909 D.S. 150537

ALUMINUM LIGHTING ARRESTERS.

Three sets of aluminum arresters are placed in series and connected from the positive ring of the rotary through a fuse to ground. The most important characteristic of the aluminum cell is its critical voltage which depends upon the hydroxide film of aluminum on the surface of the aluminum plates formed by putting them through chemical and electro-chemical treatments. When first placing the cells in circuit it is necessary to place a set of lamps across them because the film would not form if too much current were flowing and hence cause the fuse to blow. After the electrolyte has been used for a number of months it turns from a colorless liquid to a dark brown solution and then current passes freely across the cells and hence it is necessary to renew the electrolyte.

WIRING DIAGRAM AND ELECTRICAL CONSTRUCTION.

HIGH TENSION COMPARTMENT.

The Edison Co's 9000 volt cable enters the sub-station basement from the underground tile ducts to the C. E. Co. pot. head. It then passes to three knife switches, two sets of current transformers and line oil switch which are connected by 1" copper tubing. Next we pass through 2" X ¼" line buses and transfer buses, the latter being used to transfer the power upon one line to some other rotary if necessary, we then pass through the rotary Oil switch and then delta of transformers (1" tubing) through secondary and reactance and then out of high tension room to the six rings of the rotary. The 1" copper tubing is used for the purpose ofstability.

The low tension copper is 3" X ¼" bus, three being used per conductor, a space of ¼" being left between each piece of copper to allow plenty of cooling surface.

The high tension compartment is kept under ¾ oz. pressure, three fans being used for the cooling of the transformers and reactances. Each fan has eight curved blades (2'8" X 1'6" each). There is a distance of 4" from the shaft of the fan to the end of the blade. These fans are located on the outside at one end of the high tension compartment. Each fan has an orafice of 3' X 3'

Air lock doors are used for the purpose of entering the high tension compartment.

Next we pass to the D. C. side of the rotary. The negative side of the machine is connected to a switch on the machine through 4-5" X ¼" copper to the 2-10" X ¼" neg. bus. This negative bus

runs the entire length of the sub-station under the rotarys. The positive 600 V bus (4-5" X ¼" Copper) passes directly up to the switch board, through recording wattmeter, main switch, ammeter shunt, circuit breaker to positive (2-10" ¼ Copper) bus which extends the entire length of switch board through to feeder panels and thence to 1,000,000 C. M.covered lead sheath cable to under ground tile ducts to trolley. The tile ducts in the station are in a concrete trench imbedded in concrete directly under the switch board. The trench is covered with cast iron plates with holes bored between each plate for the purpose of allowing the feeder cable to pass through. The feeder passes through a porcelain floor insulator which rests on alberine stone behind the switch board before coming to the feeder panel.

The shunt field of the rotary is regulated by means of a hand operated rheostat which is located under the switch board. The copper tubing is bent into proper shape by first filling the tube with sand and plugging the ends and heating. The sand is used to keep the tubes from kinking the copper. The copper buses are bent by means of a hand operated machine.

There are three sets of current transformers, one set is used for overload relay, another set for the three single phase wattmeters and the third set for an ammeter power factor indicator and over load relays. In case an overload comes on,the relay trips the oil switch. The pot. transformers are connected and used for the A. C. Wattmeter and Voltmeters.

OPERATION.

Each station has three shifts of men every twenty-four hour. Each shift has an operator and a helper, also a janitor for the day shift.

The load is read and recorded every fifteen minutes and the watt meters are recorded every day. As the load comes on in the rush hours and the machine becomes over-loaded another converter is thrown on the line.

Each month the converter brushes are inspected; carbon brushes are used on the D. C. side and copper brushes on the rings, with the exception of one carbon brush on each ring for the purpose of lubrication.

Each week the transformers are blown out by means of a double cylinder air compressor placed in the basement.

The load on a railway system is constantly fluctuating, hence to keep the voltage up to 600 volts it has been found that a compound rotary is most efficient and therefore the power factor will be kept at practically unity when full load is applied. All the series windings of the machine may be connected in series by means of the negative equalizer bus which is composed of two 10" x $\frac{1}{4}$" pieces of copper placed directly under the machines. This bus is connected to the machines by means of 2,000,000 C. M. rubber covered stranded cables. The purpose of this bus is to keep the load equal on all machines.

THE SUB STATIONS AND POWER HOUSES HAVE THE FOLLOWING FEEDER AND AUXILIARY PANELS. (December 1910)

LOCATION	FEEDER PANELS	AUX. PANELS
Van Buren & Jefferson	34-1800 amp.plus 9-2000 amp.	2-2000 amp.
Milwaukee Ave.	24-2000 amp.	2-2000 amp.
West 25th, & Leavitt St.	22-2000 amp.	2-2000 amp.
Lill Ave.	27-2000 amp.	2-2000 amp.
Grand Ave. & 40th.	23-2000 amp.	2-2000 amp.
La Salle & Ill. St.	40-2000 amp.	2-2000 amp.
Hobbie St. P. H.	(17- 600 amp (9-1200 amp. (2-1800 amp. (4-2000 amp.	
Western Ave. P. H.	52-1500 amp. 2-Lake St. L.	

The feeders panels are not included in the G. E. contract because it is a variable quantity. These panels have S.P. D. T. switches so that in case anything breaks on the curcuit breakers the switches are thrown down and the current passes through the auxiliary panel, along the auxiliary bus which is in back of the board through the feeder panel switch to feeder cable.

BUS DISTRIBUTION.

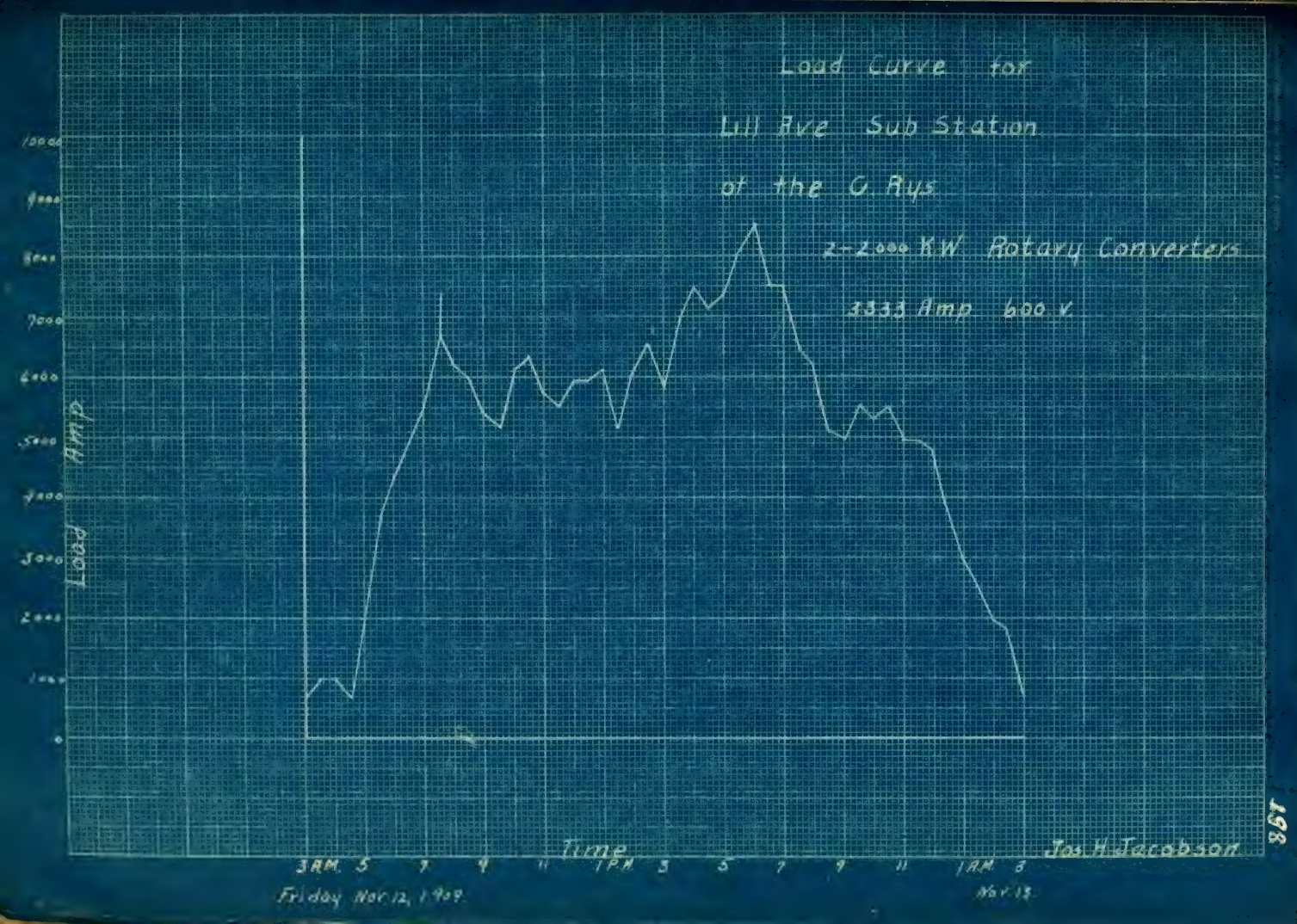
Van Buren St. Sub.	4	Buses to	Western Ave. P. H.
	7	"	Ill. St. Sub.
	2	"	Milwaukee Ave. Sub.
	1	"	Hobbie St P. H.
	2	"	25th and Leavitt Sub.
Milwaukee Ave. Sub.	2	"	Van Buren St Sub.
	2	"	Grand Ave. Sub.
	3	"	California Ave. P. H.
	2	"	Hobbie St. P. H.
	3	"	Western Ave. P. H.
25th and Leavitt St. Sub.	2	"	Van Buren St. Sub.
	2	"	Western Ave. P. H.
Lill Ave. Sub.	6	"	California Ave. P. H.
	4	"	Hobbie St. P. H.
	3	"	Edgewater P. H.
Grand Ave. Sub.	2	"	Milwaukee Ave. Sub.
	4	"	California Ave. P. H.
	4	"	Western Ave. P. H.
	3	"	Cicero P. H.
La Salle St. Sub.	7	"	Hobbie St. P. H.
	7	"	Van Buren St. Sub.
Hobbie St. P. H.	7	"	Illinois St. Sub.
	2	"	Milwaukee Ave. Sub.
	4	"	Lill Ave. Sub.
	1	"	California Ave. Sub.
	1	"	Van Buren St. Sub
Western Ave. P. H.	4	"	Van Buren St. Sub.
	4	"	Grand Ave. Sub.
	3	"	Milwaukee Ave. Sub.
	1	"	California Ave. P. H.
	2	"	25th and Leavitt St. Sub.
California Ave. P. H.	3	"	Milwaukee Ave. Sub.
	6	"	Lill Ave. Sub.
	4	"	Grand Ave. Sub.
	1	"	Hobbie St. P. H.
	1	"	Western Ave. P. H.
	2	"	Edgewater P. H.
Edgewater	3	"	Lill Ave. Sub.
	2	"	California P. H.
Cicero	3	"	Grand Ave. Sub.

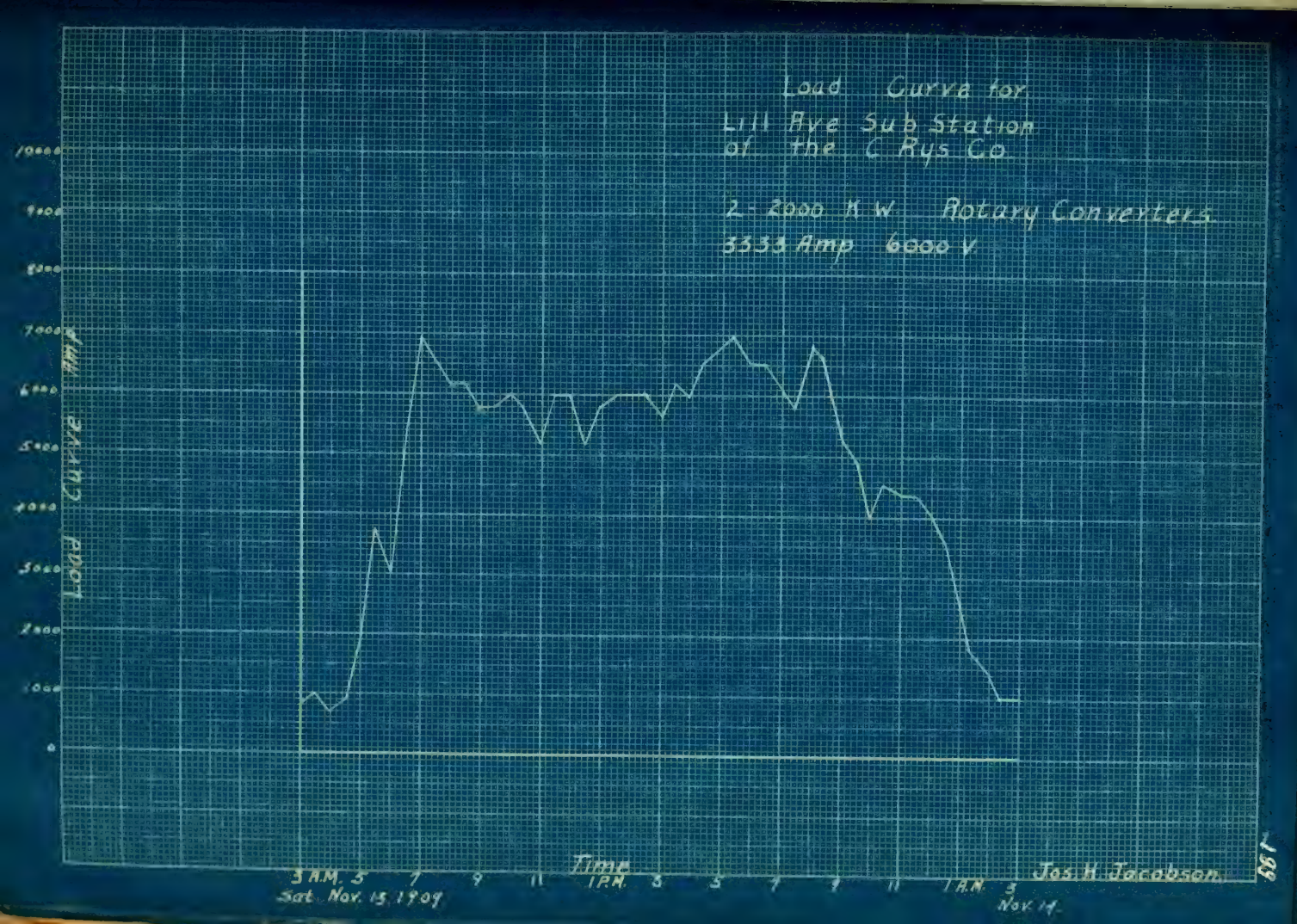
SYSTEM OF SUB-STATIONS AND POWER HOUSES

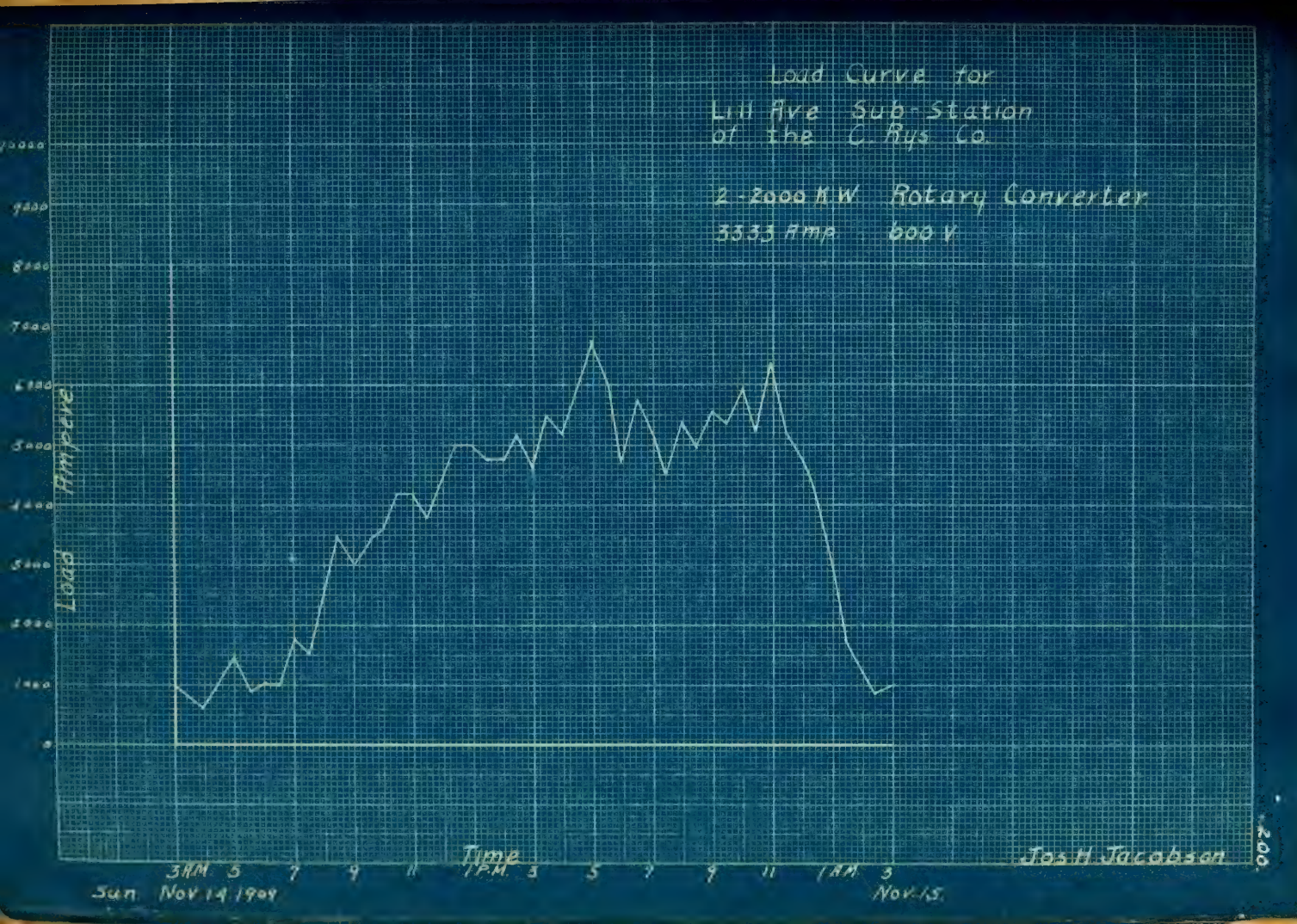
OF CHICAGO RAILWAYS COMPANY.
SEE SECTIONIZED MAP. DRAWING No. 852-C.

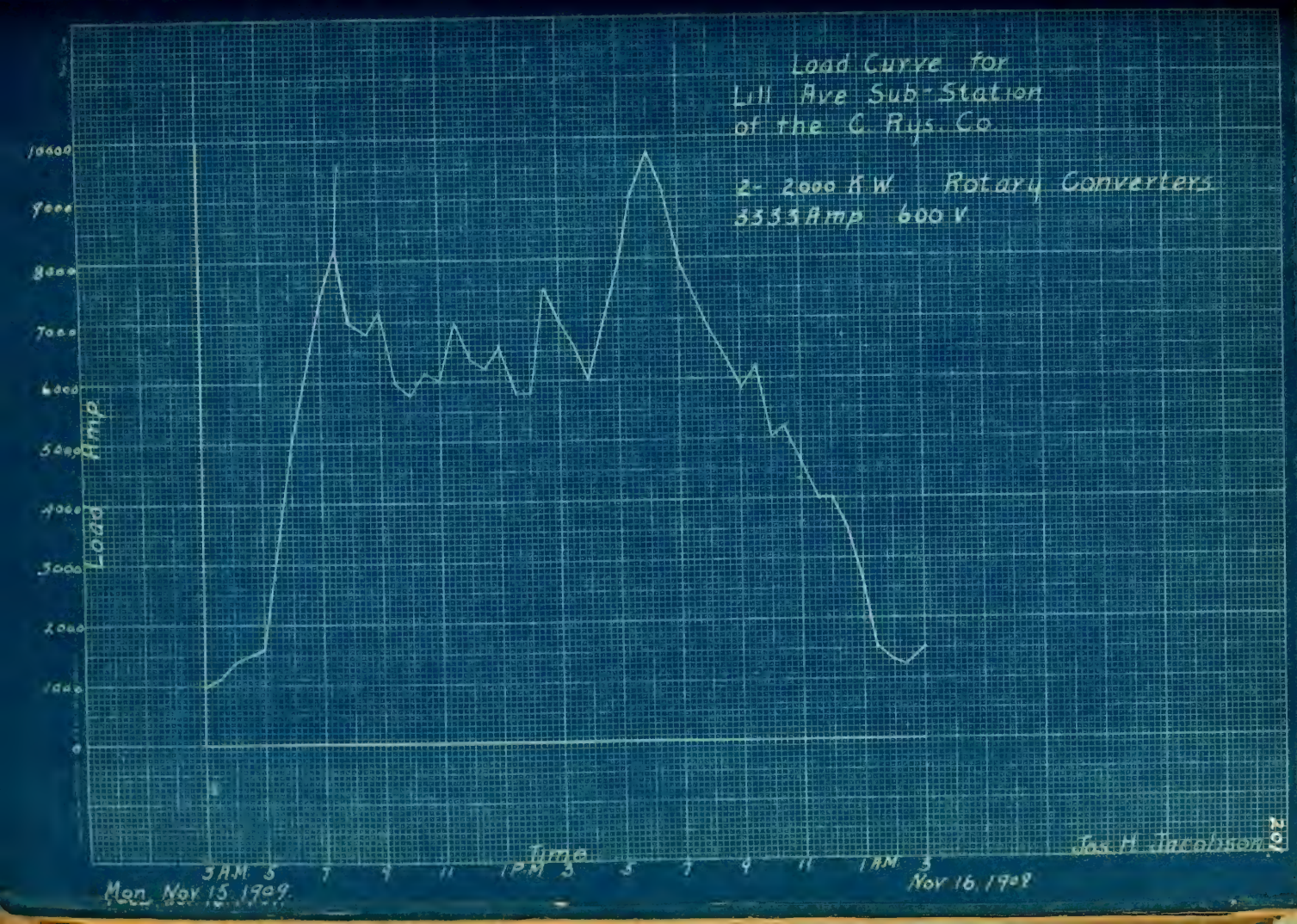
LOCATION	ULTIMATE CAPACITY		TOTAL FLOOR AREA SQ. FT.	SQ. FT PER K.W.
Van Buren & Jefferson St	6X2000 eq.	12000 K.W.	8060	.673
Milwaukee Ave.	3X2000 eq.	6000 K.W.	4742	.790
West Twenty-fifth & Leavitt St.	3X2000 eq.	6000 K.W.	4294	.716
Hill Ave.	3X2000 eq.	6000 K.W.	4294	.716
Grand Ave. & 40th,.	3X2000 eq.	6000 K.W.	4294	.716
La Salle & Ill. St.	5X2000 eq.	10000 K.W.	7100	.710
Hobbie St. P. H. (old)	1X1500 K.W. eq.)	3900 K.W.		
	3X 800 K.W.)			
Western Ave. P. H. (old)	3X1500 K.W.)			
	1X1400 K.W. eq.)	8800 K.W.		
	1X1650 K.W.)			
	1X1250 K.W.)			
Cicero P. H. (old)		2930 K.W.		
California P. H. (old)		5500 K.W.		
Edgewater P. H. (old)		1815 K.W.		
	Total	68945 K.W.		

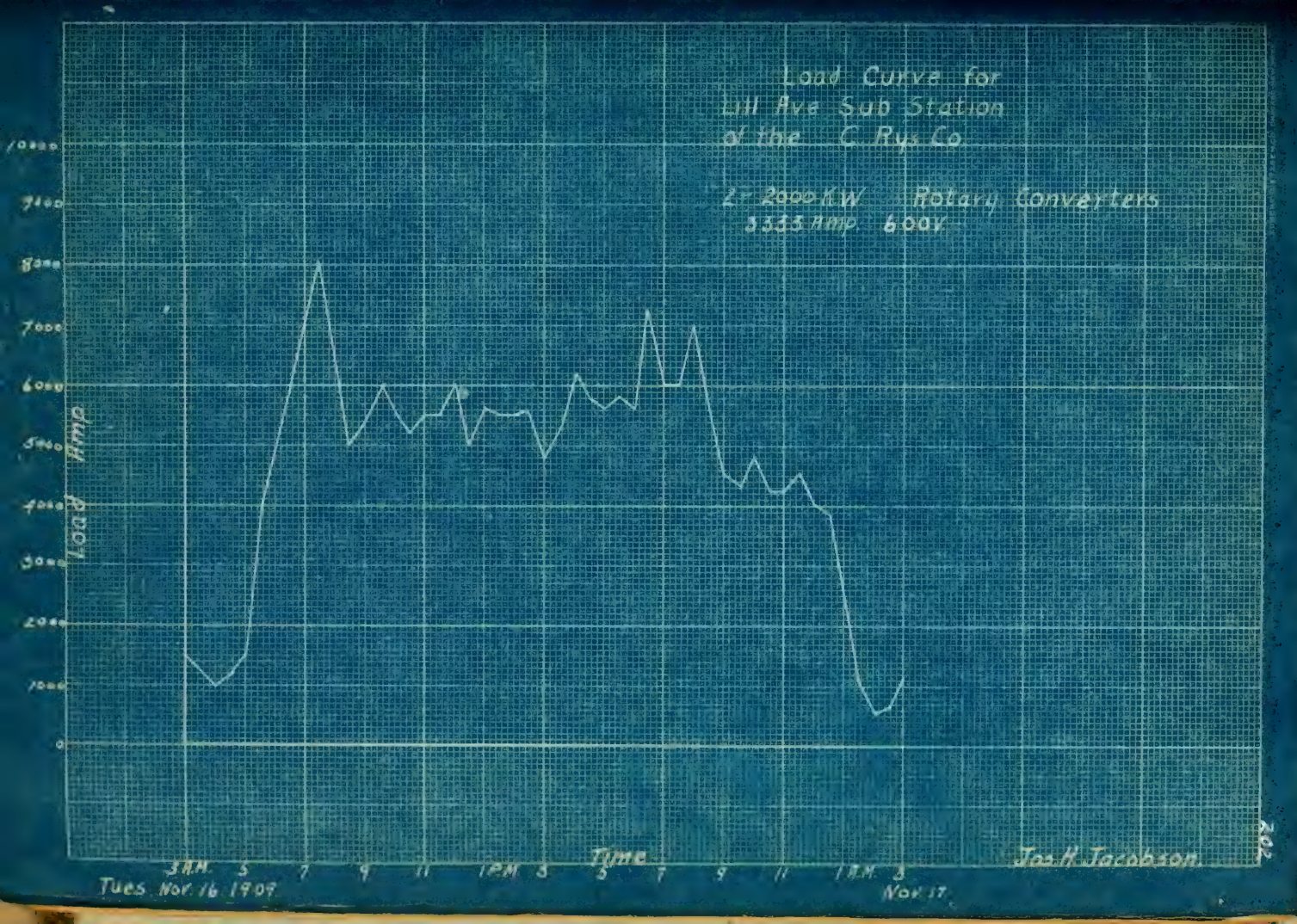
All the above sub-stations and power houses are tied together by means of bus lines. Most bus lines are 1000000 C. M. rubber covered stranded lead sheath cable extending from one station feeder panel to another station, feeder panel. At any time the load may be shifted from one station to another by means of these lines.

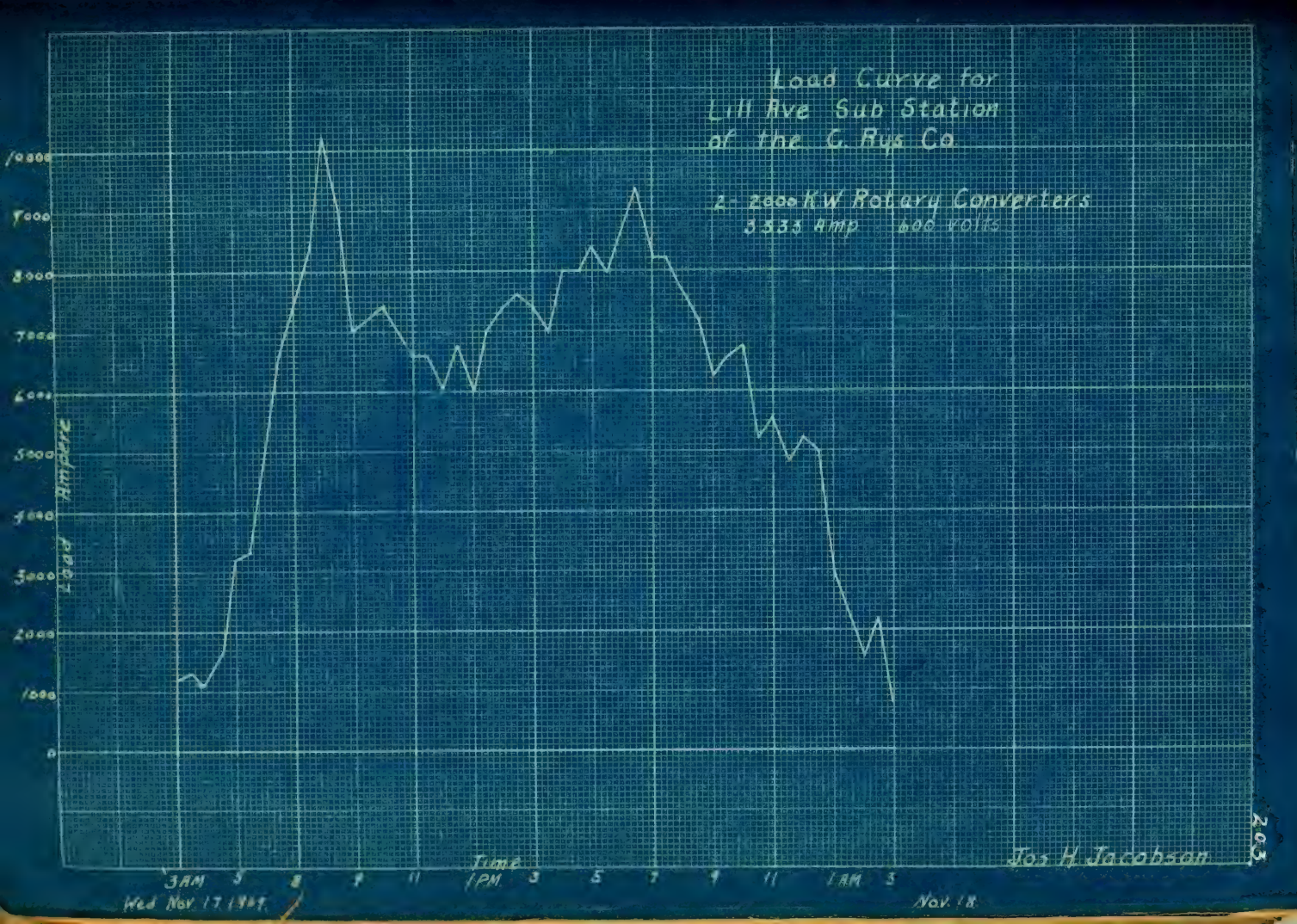

Load Curve for
Lill Ave Sub Station
of the C. Rys
2-2000 K.W. Rotary Converters
1333 Amp 600 v
Load Amp
Time
3AM 5 7 9 11 1PM 3 5 7 9 11 1AM 3
Friday Nov 12, 1909
Nov 13
Jos H Jacobson
867


Load Curve for
Lill Ave Sub Station
of the C Rys Co
2-2000 K.W. Rotary Converters
3333 Amp 6000 V
K.W. Input
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
3 A.M. 5 7 9 11 Time 1 P.M. 3 5 7 9 11 1 A.M. 3
Sat. Nov. 13 1909
Nov 14.
Jos. H. Jacobson.
186

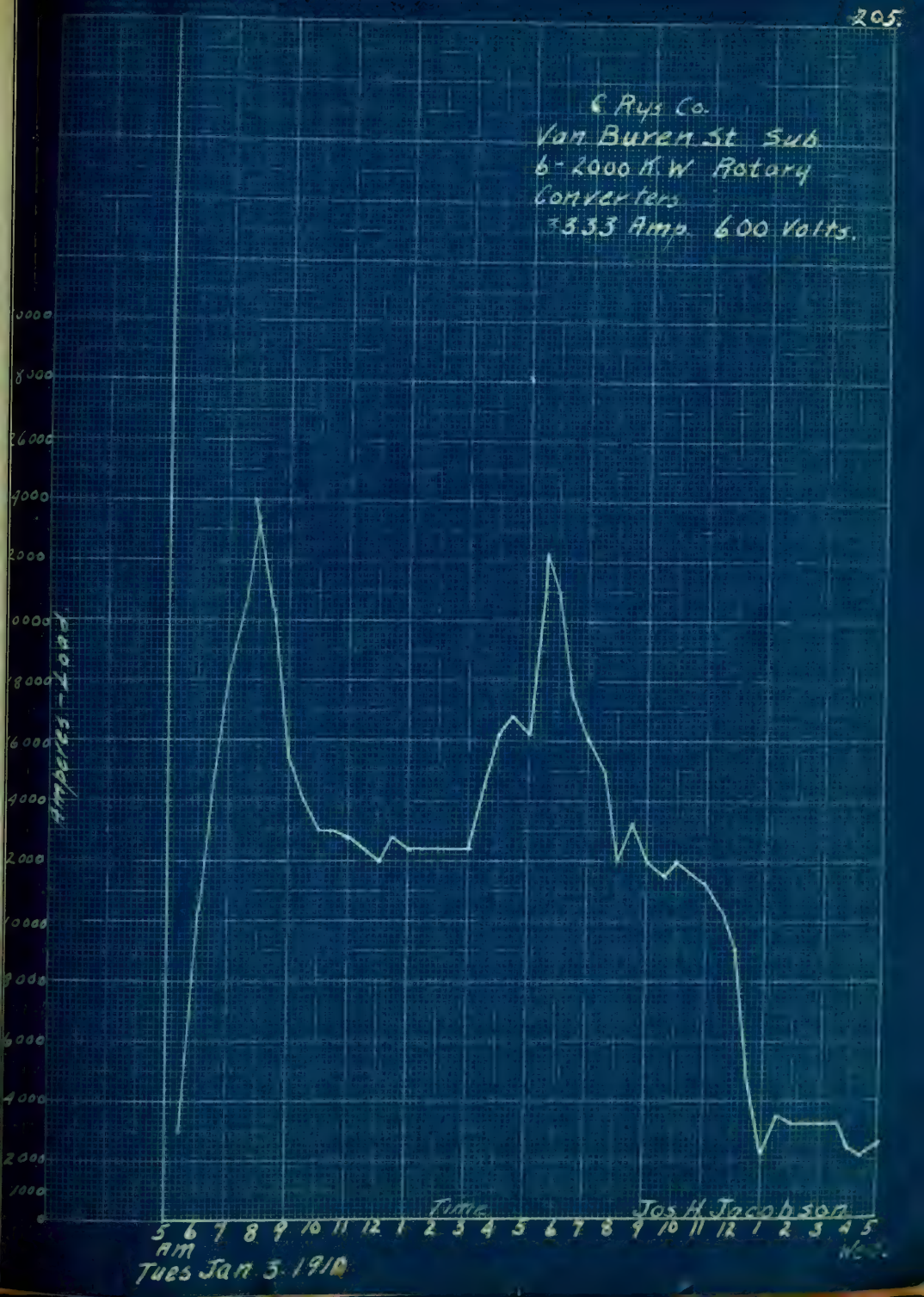

Load Curve for
Lill Ave Sub-Station
of the C. Rys Co.
2-2000 KW Rotary Converter
3333 Amp 600 V
Kilowatt Load
Time
3AM 5 7 9 11 1PM 3 5 7 9 11 1AM 3
Sun Nov 14 1909
Nov 15.
Jos H Jacobson


Load Curve for
Lill Ave Sub-Station
of the C Rys. Co.
2- 2000 K.W. Rotary Converters
3333 Amp 600 V.
Load Amp
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Time
3 A.M. 5 7 9 11 P.M. 3 5 7 9 11 A.M. 3
Mon. Nov 15. 1909.
Nov 16. 1909
Jas. H. Jacobson.
201


Load Curve for
Hill Ave Sub Station
of the C. Ry. Co.
2 - 2000 KW Rotary Converters
5333 Amp. 600 V.
Load Amps.
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
3 A.M. 5 7 9 11 1 P.M. 3 5 7 9 11 1 A.M. 3
Time
Tues. Nov. 16 1909
Nov. 17
Jos. H. Jacobson.
202


Load Curve for
Lill Ave Sub Station
of the C. Rys Co.
2- 2000 KW Rotary Converters
3333 Amp 600 volts
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Load Amperes
Time
3AM 5 8 P 11 1PM 3 5 7 9 11 1AM 3
Wed Nov. 17 1909.
Nov. 18
Jos H Jacobson
203

Load Curve for
Lill Ave Sub Station
of the C Rys Co
2- 2000 KW G.E. Rotary Converter
3333 Amp 600 volts
Kilowatt Load
Time
3AM 5 7 9 11 1PM 3 5 7 9 11 1AM 3
Thur Nov 18 1909
Nov 19 1909
Jas H Jacobson
207


C Rys Co.
Van Buren St Sub
6-2000 K W Rotary
Converters
333 Amp. 600 Volts.
Watts
Time
Jos H Jacobson
5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5
AM
Tues Jan 5 1910

ROTARY CONVERTER SUBSTATIONS.

CHICAGO CITY RAILWAY COMPANY.

LOCATION	ULTIMATE CAPACITY	FLOOR AREA Sq. Ft.	SQ. FT. per K. W. Ult. Cap.
Twentieth & Dearborn	2X1000 = 2000 5X2000 =10000 12000 K.W	8920	.743
Sixty-third & Wentworth Ave	2X1000 = 2000 5X2000 = 10000 12000 K.W	8420	.702
Forty Second St & Wabash Ave.	7X2000 = 14000 K.W.	8700	.621
Forty-eight & Honore Sts.	5X2000 = 10000 K.W.	6447	.645
Plymouth Court.	2X1200 = 2400 K.W.		
" "	Storage Battery = 3240 K.W.		
	TOTAL 52640 K.W.	Av.	.677

The Storage Battery at Plymouth Ct. consists of 275 cells at 2 volts per cell or 550 volts.

Example: 7:30 A. M. to 8:07 AM . ------4500 Amp. The Voltage dropped from 560 to 460. Charging rate 1200 Amp. 550 to 700 volts. Charging from 8:50 A. M. to 2 P. M. Discharge 5:10 P.M. to 6:20 P. M. 4500 Amp. Charging from 7:50 P. M. to 11:45 P. M.

After charging the cells the specific gravity was 1194. These cells are used only for the morning and evening peak loads. They are charged by means of a motor generator set which is also thrown on the line while the cells are discharging. The rating of the motor generator set is as follows:
Motor, 6 Pole HP 410 550 V. 620 amp. Interpole
Generator 12 pole, 500 R.P. M. 550 V 3940 Amp. Interpole

ROTARY CONVERTER SUBSTATION.

SOUTH CHICAGO AND CALUMET RAILWAY COMPANY.

LOCATION	ULTIMATE CAPACITY
GRAND CROSSING	3-1000 K. W.
SOUTH CHICAGO	3-1000 K. W.
ROSELAND	2-1000 K. W.
Total	8000 K. W.

The above are combination Edison and Railway stations.

The Edison Company have in these stations synchronous motors direct connected to an alternating current generator.

The capacity of the motor is, HP. 1340, 300 R.P.M., 64 amp. 25 cycle, 9000 Volt, 10 pole.

The Capacity of the alternating current generator is 24 pole, 300 R.P.M., 139 Amp. 4130 volts.

The exciter is direct connected to an induction motor. Exciter capacity 4, 50, 750, 390 amp.

Induction Motor capacity 4, 75H, 750 RPM, 25 cycle, 230 volts, 185 amp.

The H. T. voltage comes in for the railway converters and frequently changes at 20,000 volts. In the first case the voltage is dropped by means of transformers to 430 volts, while in the second case it is dropped to 9000 volts.

EFFICIENCY:

It is sufficient to compare the converter, the synchronous motor, direct current generator set since the induction motor is inherently less efficient than the synchronous motor. The efficiency of stationary transformers of large size varies from 97 percent to 98 percent with an average of 97.5 percent. That of the converters or synchronous motors varies between 91 percent and 95 percent, with 93 percent as average and that of the direct current generator between 90 percent and 94 percent with 92 percent average.

Thus the converter with its step down transformers will give and average efficiency of 90.7 percent,a direct current generator connected to a synchronous motor with step down transformers, an efficiency of 83.4 percent without step down transformer an efficiency of 85.6 percent. Hence the converter is more efficient.

Mechanically the converter has the advantage that no transfer of mechanical energy takes place since the torque consumed by the generation of the direct current and the torque produced by the A. C. are applied at the same armature conductor, while in a direct current generator drawn by a synchronous motor the power has to be transmitted.

EXAMPLES OF 6-2000 K.W. ROTARY CONVERTER EFFICIENCY.

JAN. 3rd, 1910. VAN BUREN ST. SUB. C. RYS. CO.

Sum of A.C. wattmeters.		Rotary No.	D. C. Wattmeter.
24700	K.W. H.	Rotary 1	22000 K. W. H.
34800	K. W. H.	Rotary 2	31600 K. W. H.
28400	K. W. H.	Rotary 3	25000 K. W. H.
32400	K. W. H.	Rotary 4	30000 K. W. H.
32200	K. W. H.	Rotary 5	26700 K. W. H.
21300	K. W. H.	Rotary 6	20700 K. W. H.
173800	K. W. H.		156000 K. W. H.

EFFICIENCY = 156000 ÷ 173800 = 90%.

EXAMPLES OF 2000 K. W. ROTARY CONVERTER EFFICIENCY.

Month of July, 1910. CHICAGO RAILWAYS.

ROTARY #1.

D. C. Wattmeter reading		633000 K. W. H.
A. C. Wattmeter reading	Phase - A	233000 K. W. H.
A. C. Wattmeter reading	Phase - B	236300 K. W. H.
A. C. Wattmeter reading	Phase - C	216500 K. W. H.
Sum of A. C. Readings		685800 K. W. H.

Efficiency = 633300 ÷ 685800 = 92.4%

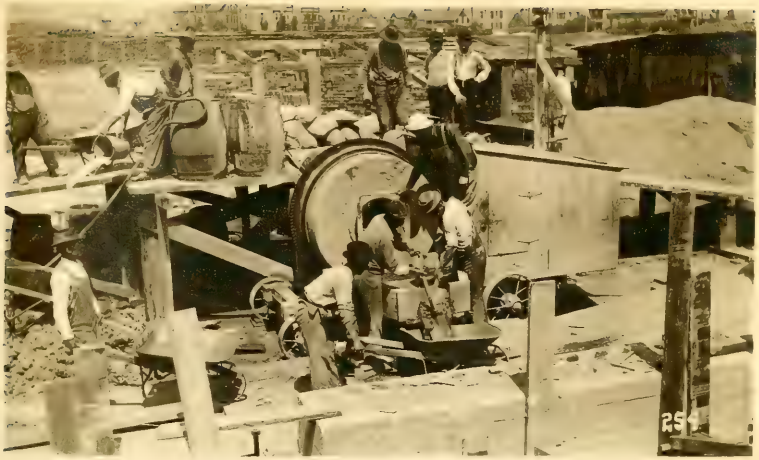
ROTARY #2

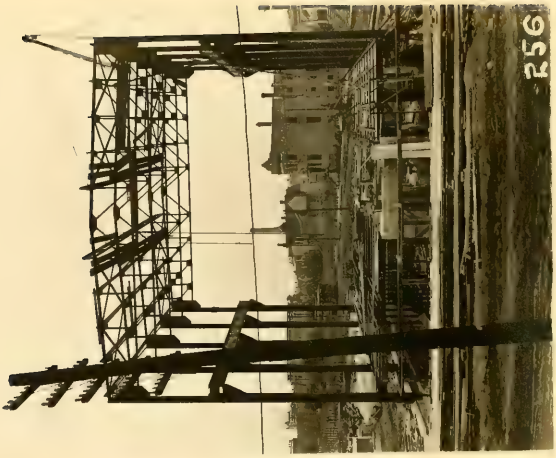
D. C. Wattmeter reading		576000 K. W. H.
A. C. Wattmeter reading	Phase - A	215400 K. W. H.
A. C. Wattmeter reading	Phase - B	217200 K. W. H.
A. C. Wattmeter reading	Phase - C	216300 K. W. H.
Sum of A. C. Readings		648900 K. W. H.

Efficiency = 576000 ÷ 648900 = 88%

INDEX TO PROGRESS PICTURES.

NO.
254-----Operation of mixer for concrete foundation.
255-----Erection of steel beams.
256-----Steel Struction completed.
257-----Placing of brick
262-----Placing of brick.
259-----Building of chimney.
260-----Building brick structure.
261-----Building brick structure.
267-----Placing of book tile on roof.
268-----Building of roof.
270-----Chimney.
269-----Roof.
218-----Skylights.
250-----Roof Complete.
260-----Building brick work.
259-----Building brick work
119-----Building
224-----Building
402-----Building complete.
408-----Stairs leading to basement.
188-----Boiler.
258-----Plan view of Conduit.
156-----Prior to Electrical Installation.
165-----Case-Crane.
176-----Rotary Installation.
394-----Switchboard and Rotary Installation.
169-----Switchboard and Rotary Installation.
245-----Switchboard and Rotary Installation.
276-----Electrical Installation.
387-----Electrical Installation.
381-----Laying of Asbestos Composition Flooring.
404-----Electrical Installation Complete
407-----Sump Pump for draining of Building Foundation.
395-----Air Compressor for blowing out of Machines.
268-----Placing 2 X $\frac{1}{4}$" 9000 volt copper in high tension compartment.
396-----One inch tubing in high tension compartment.
397-----One inch tubing in high tension compartment.
171-----Storage Batteries in concrete compartment.
350-----Low tension copper and high tension delta.
48-----Rear view of Switchboard.
46-----Rear view of Feeder Panels.
49-----Rear view of Switchboard.
50-----Oil switch Compartment and Mechanism.
47-----Switchboard.
51-----Rotary arriving on work Car.

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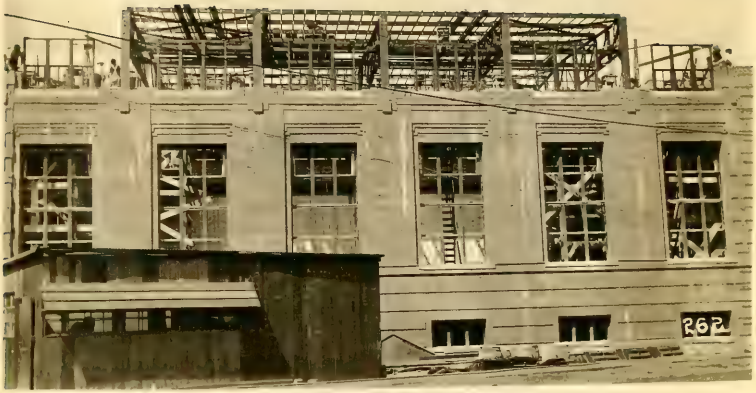
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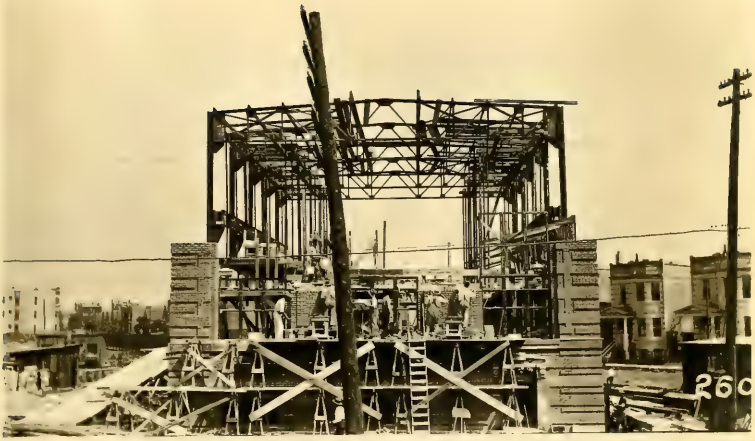
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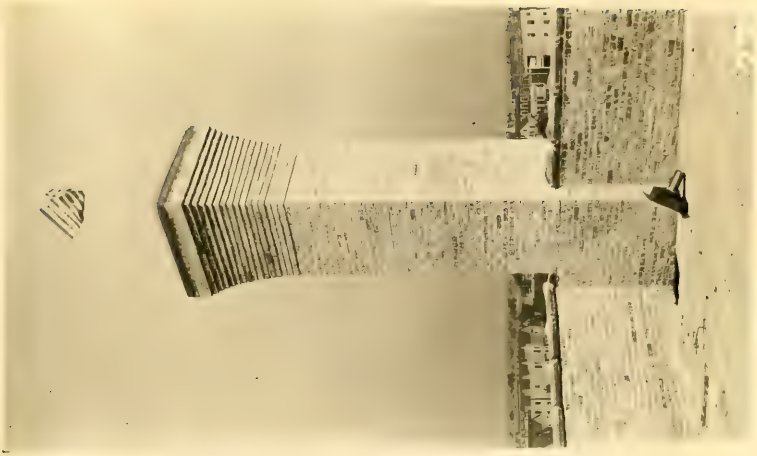

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218

250

266

1249

119

224

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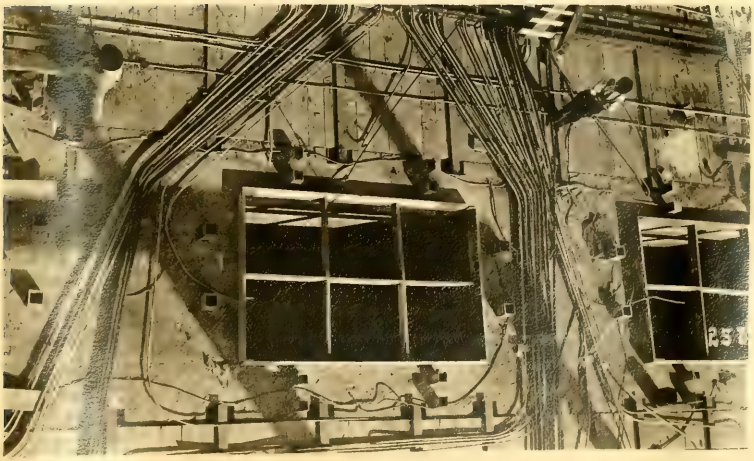

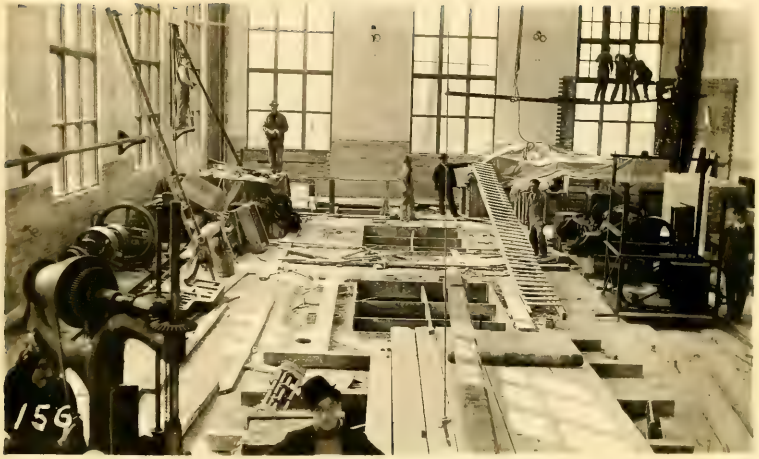
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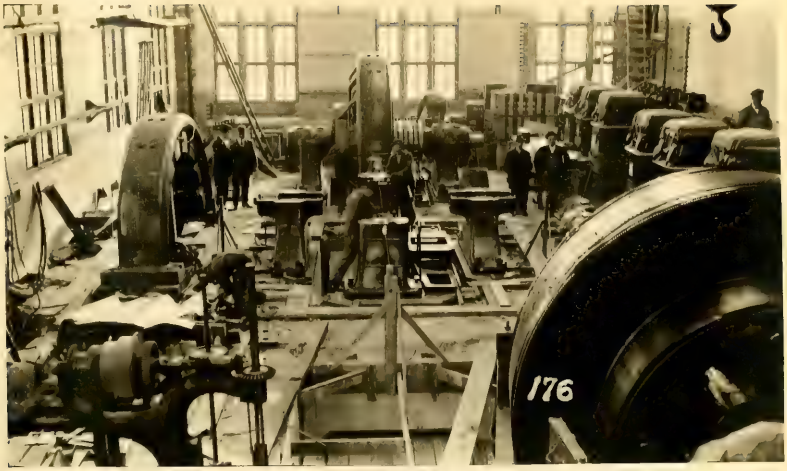
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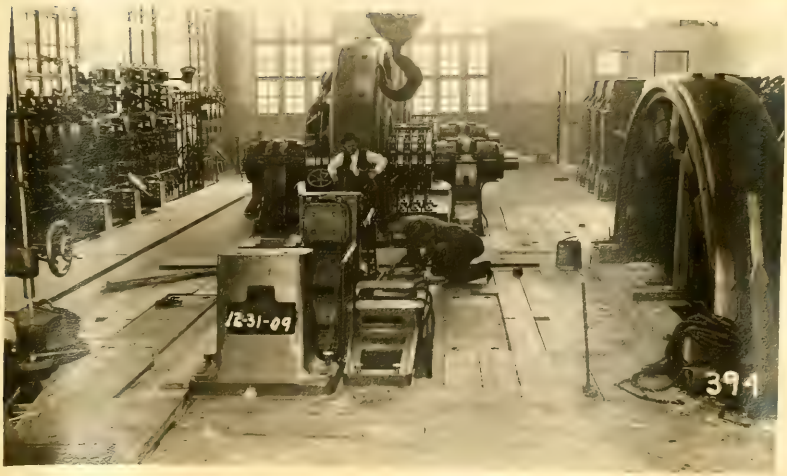
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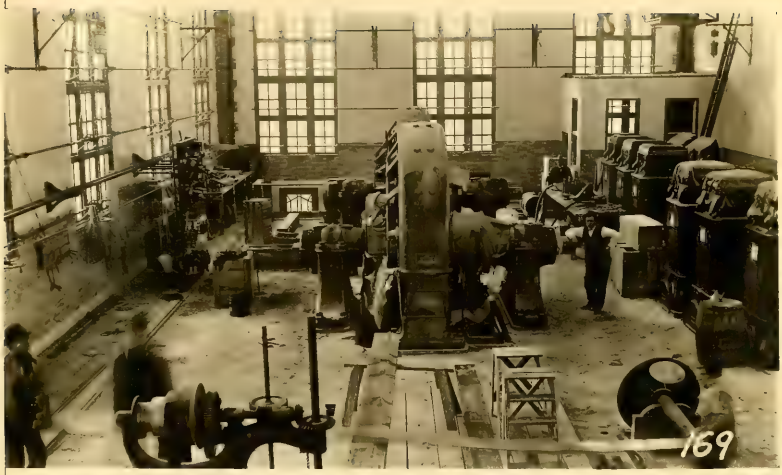
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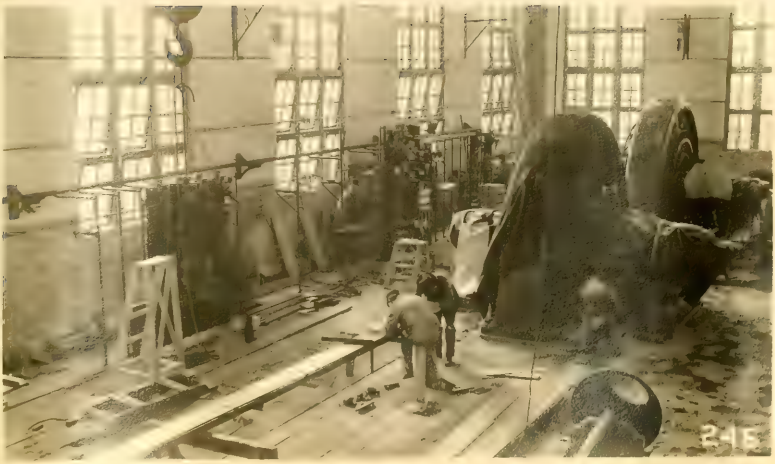
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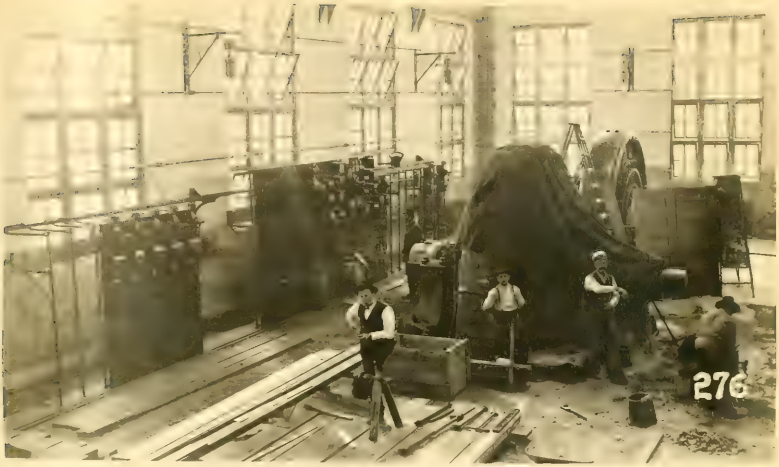
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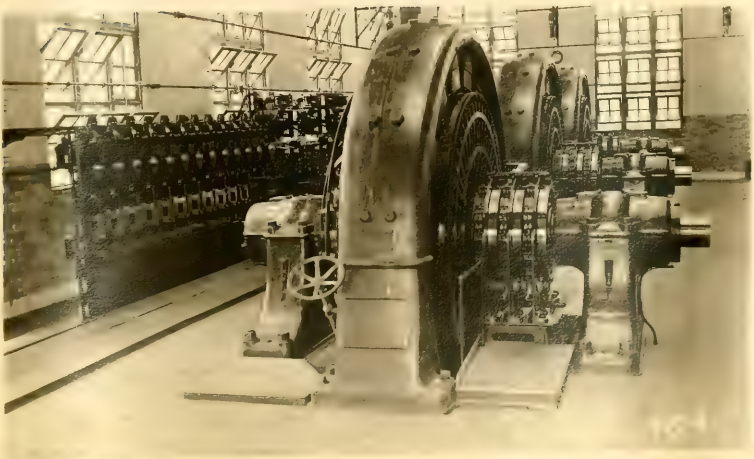

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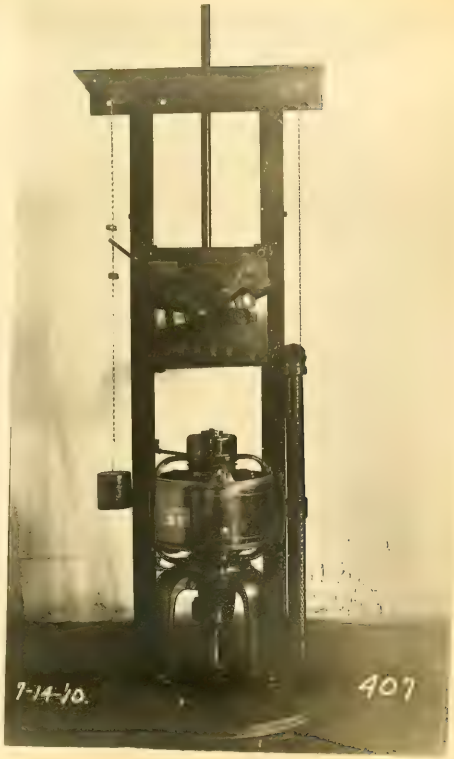
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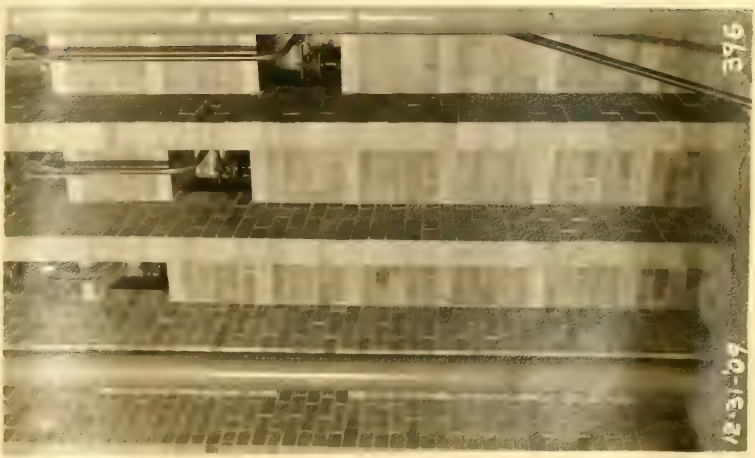
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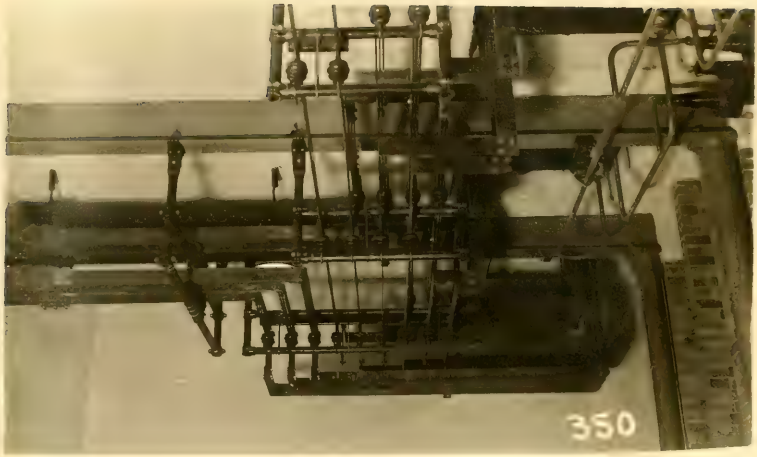
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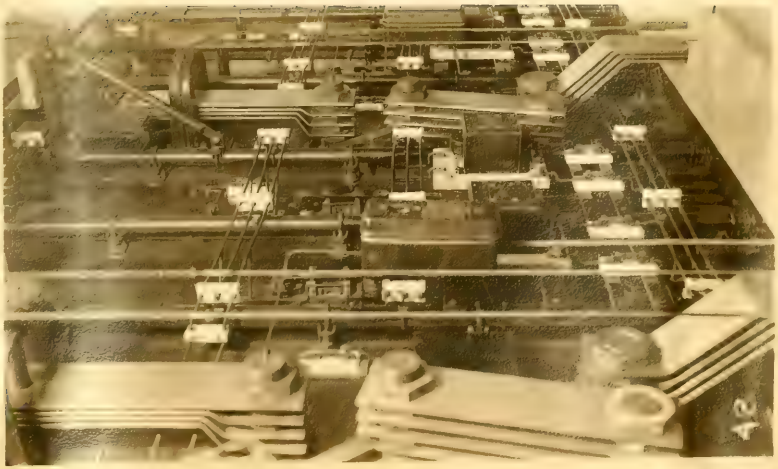
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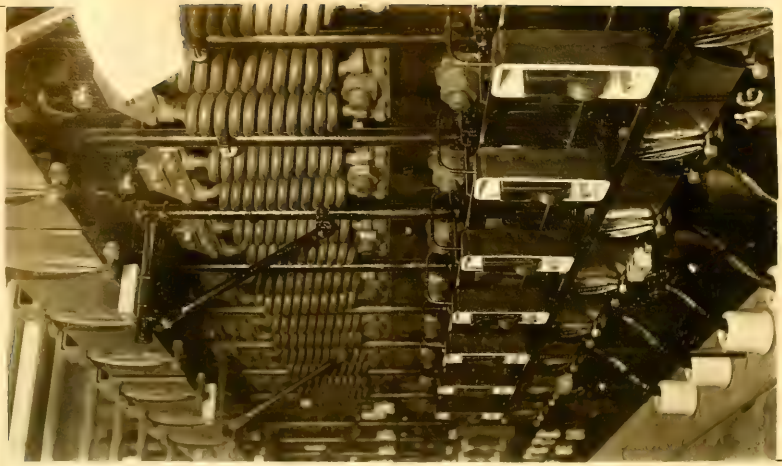

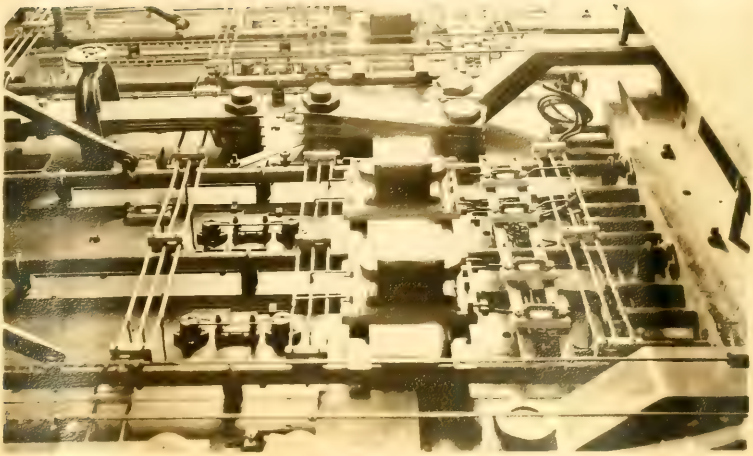

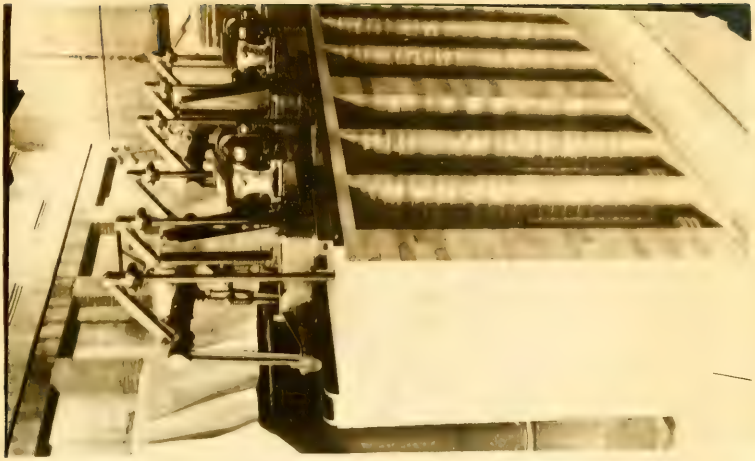

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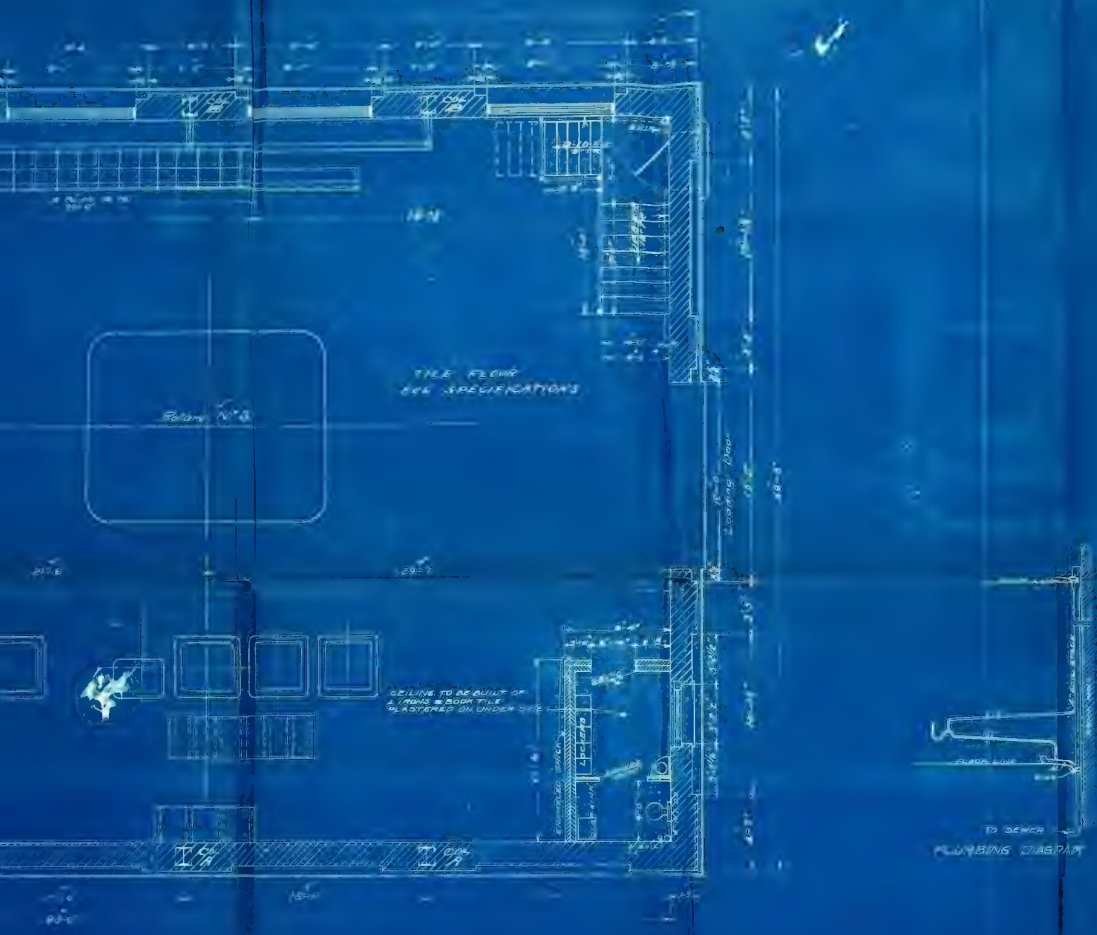
JAN 10 2008

B 372



PLUMBING DIAGRAM

F.P. NO. 2357

REVISED BY J.Z.M. DEC. 28-1908
BY CHANGING WIDTH OF TOILET ROOM FROM
7'-0" TO 9'-0"

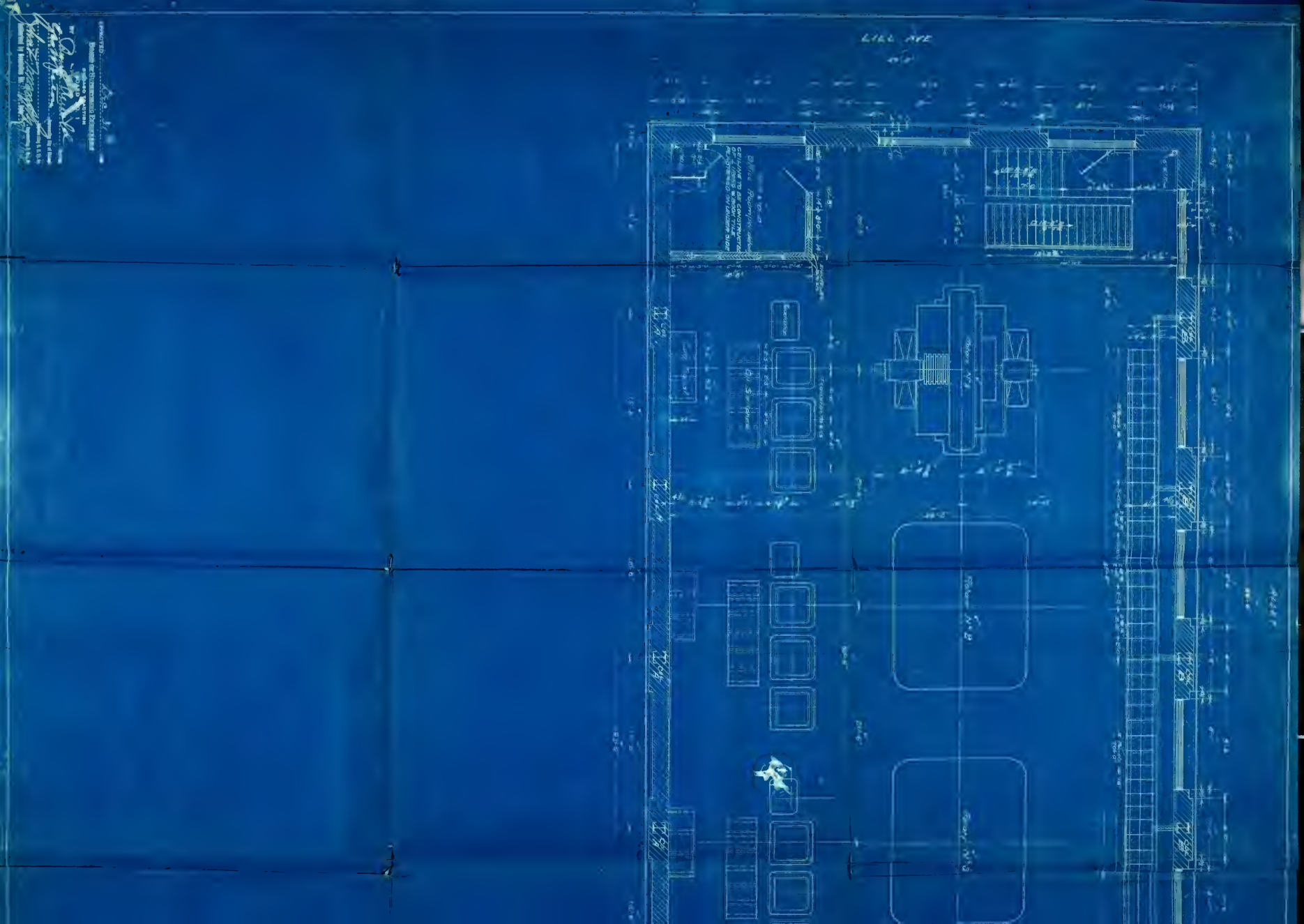
CHICAGO

FIRST FLOOR PLAN
LILL AVENUE SUBSTATION
LILL AVENUE

3-0	1/15/08	
3-0	1/15/08	
	11-29-08	
	11-30-08	
	DEC-4-08	
	DEC-7-08	

D-1408

S. ALCORN, CONSULTING ARCHITECT



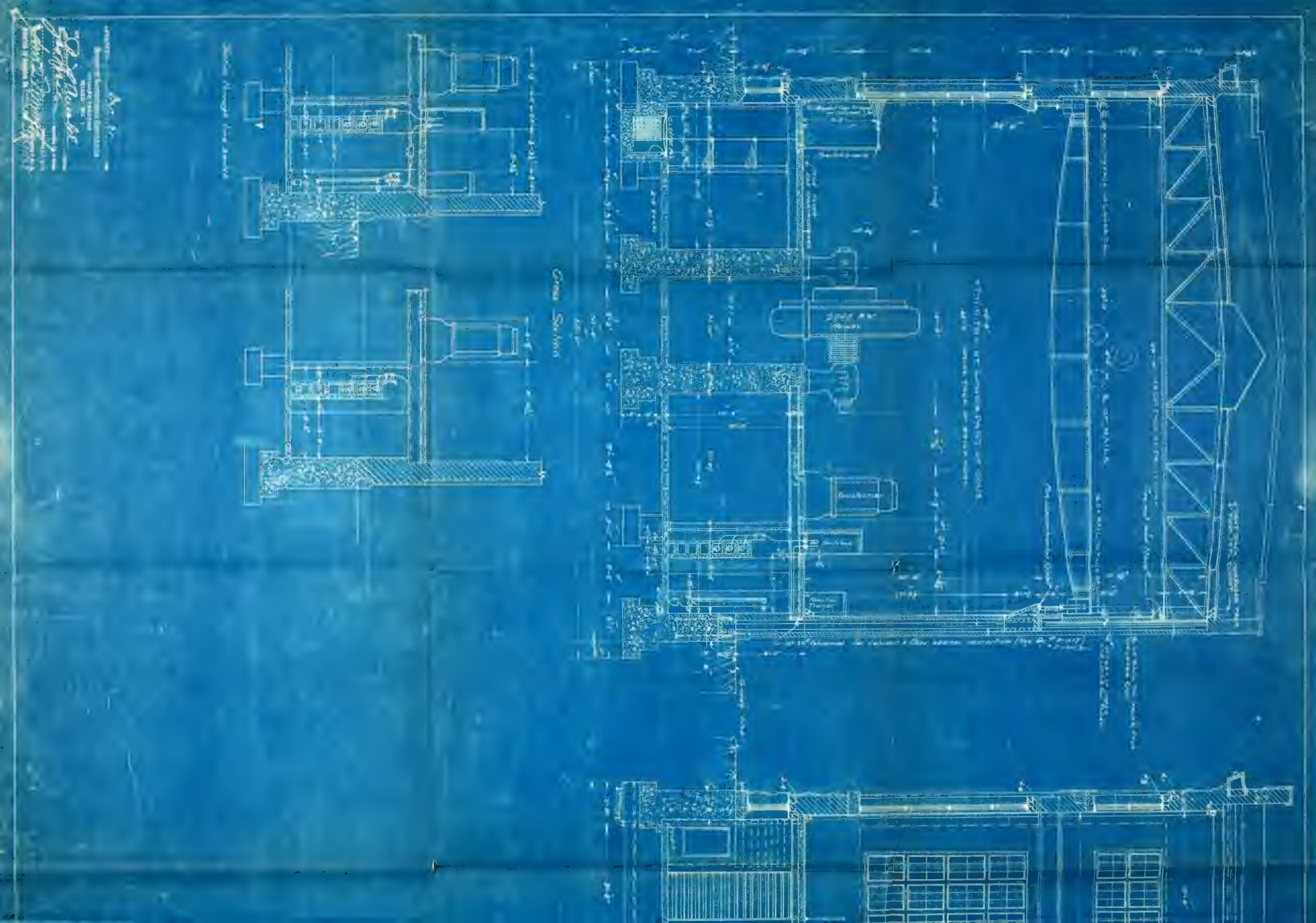
Longitudinal Section

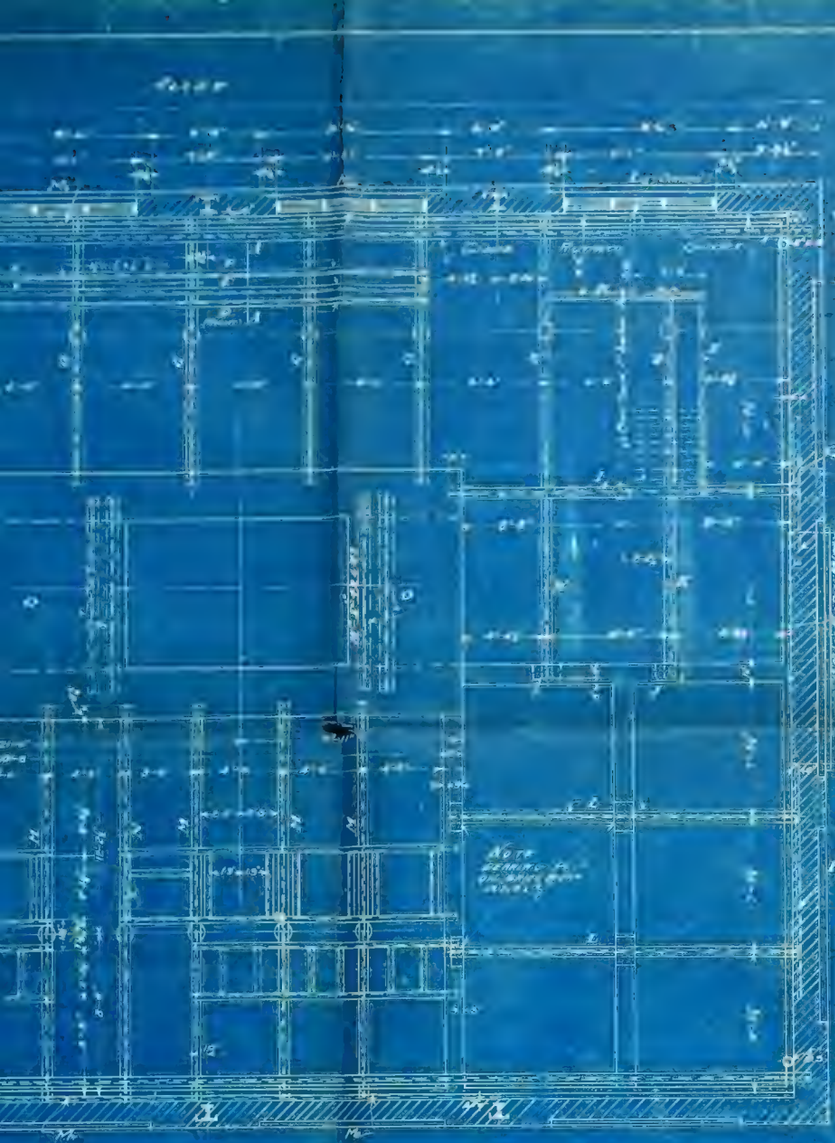
F.P. NO. 2360

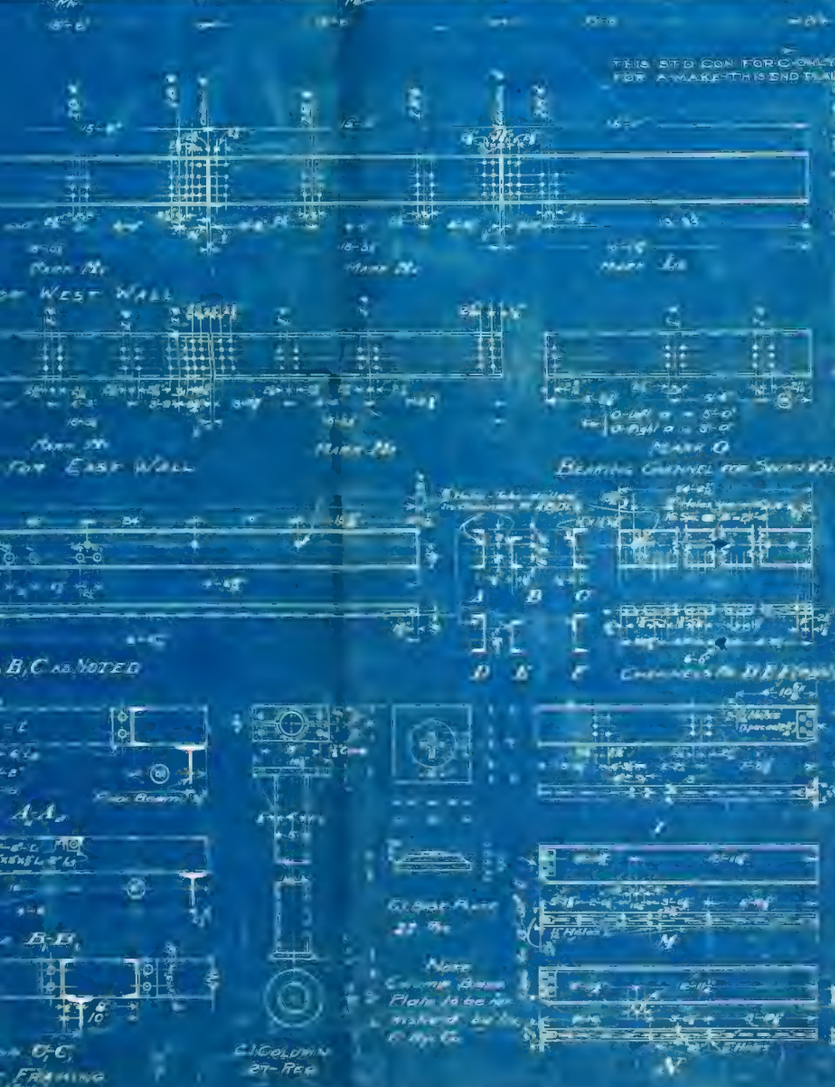
RECEIVED
JAN 19 19
CHICAGO ELEVATED

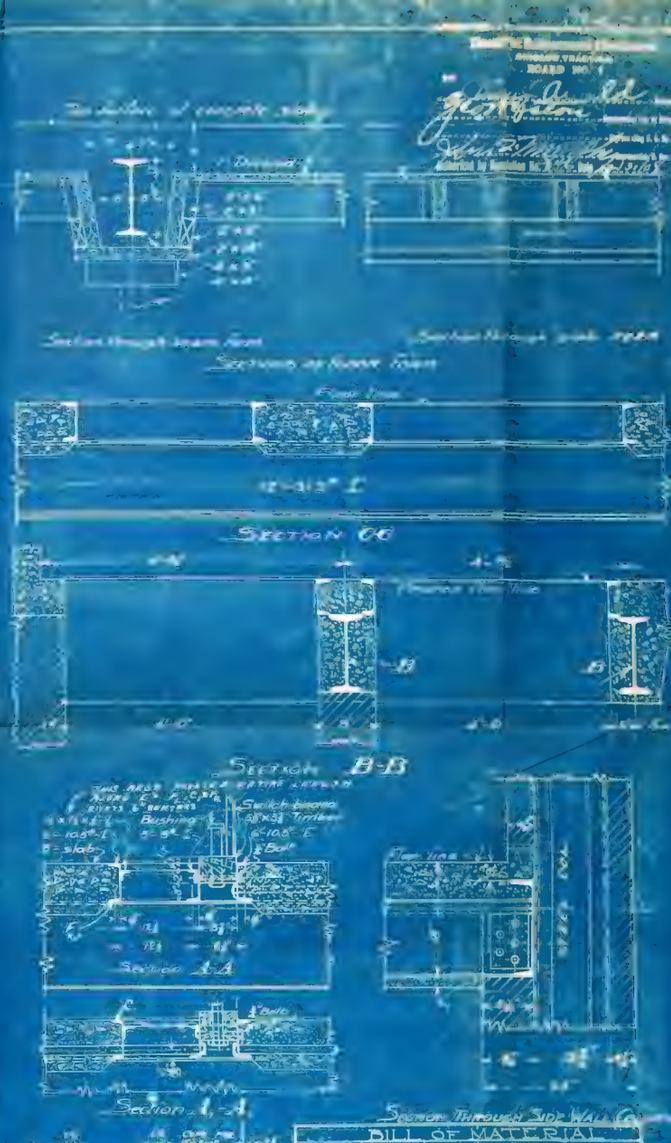
CHICAGO RAILWAY

GENERAL SECTIONS
ENT AVENUE SUBSTATION
LILL AVENUE









BILL OF MATERIAL				
MARK	NO. REQ'D	SIZE	LENGTH	REMARKS
AA	1	6"-12.5#	2'-9"	
BB	1	6"-12.5#	4'-6"	
S	6	1" ø RODS	11'-5"	ANCHOR BOLTS AS SHOWN
A	1	24"-81.0#	18'-4"	Plates as shown
B	2	" "	14'-11"	
C	1	" "	15'-4"	
D	1	" "	15'-4"	
E	3	" "	13'-11"	Like D
F	4	" "	13'-6"	Drilled as shown Like F
G	10	" "	13'-6"	" " P
H	1	" "	14'-0"	" " P
I	1	" "	15'-9"	" " J
K	2	" "	9'-8"	" " channel "
L	2	" "	15'-10"	" " channel "
M	11	" "	21'-11"	Drilled as shown on Sketch No. M
N	2	" "	17'-11"	Drilled as shown on N
O	12	12"-31.5#	10'-3"	No holes
Q	1	12"-31.5#	21'-3"	Base Detail
Y1	3	Safe Plate		See drawing
Y2	3	" "		" "
R	1	12"-31.5#	6'-11"	
A	1	6"-8"-15#	16'-7"	Drilled as shown
B	1	5"-9"-15#	16'-11"	" "
C	1	6"-8"-15#	18'-7"	Flange opposite Item C
D	1	6"-8"-15#	17'-3"	" "
E	1	5"-9"-15#	17'-3"	" "
F	1	6"-8"-15#	17'-2"	Built angle
G	2	6"-8"-15#	18'-5"	Drilled as shown
H	1	6"-8"-15#	3'-11"	
I	1	6"-8"-15#	4'-4"	Ends are drilled like M
K	1	6"-8"-15#	9'-7"	" " O
M1	8	15"-33"-42#	15'-11"	" " M
M2	8	15"-33"-42#	15'-5"	" " M
10	PLS	12"x12"x ½"		PLATES
O1	1	15"-33"-42#	11'-2"	Drilled as shown
O2	1	15"-33"-42#	11'-2"	" " "
P	1	15"-33"-42#	6'-0"	Bolt angle drilled
Q	1	15"-33"-42#	6'-0"	Holes in the center
U	1	6"-17.5#-L	12'6"	FOR LURDING DOOR

CHICAGO RAILWAYS CO.
CHICAGO, ILL.

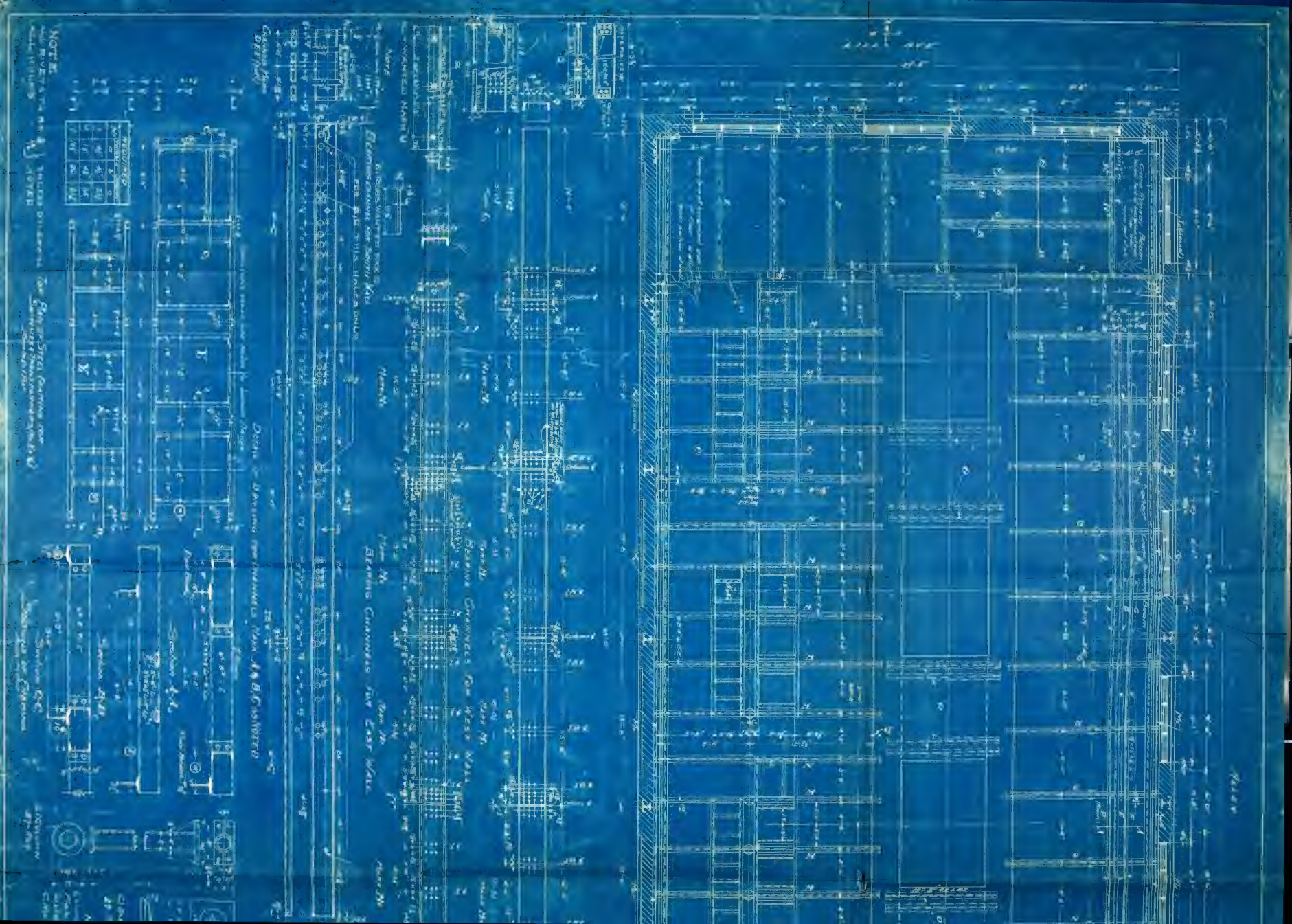
STRUCTURAL STEEL DETAILS
LILL AVE SUBSTATION
LILL AVENUE

DR. BY	J. F.	7/16/08
TR. BY		
CK. BY		7/16/08
SCALE		
REVISED		7-17-08
		8-18-08
11/12/08		11-21-08

Approved Sept. 16-1908
John L. Murphy
CHIEF ENGINEER
DWG. D-1407

S. M. CROWEN - Consulting Architect
REVISED Dec 4-08

F.P.NO.2361



PLAN

PLAN

SECTION

RD IN BASEMENT
AIR LOCK 4 WANTED

ELEVATION

SECTION

DETAIL OF DOOR IN OFFICE
FIRST FLOOR 1 WANTED

ELEVATION

SECTION

DETAIL OF DOOR IN TOILET ROOM
FIRST FLOOR 1 WANTED

UPPER
STILE

LOWER
STILE

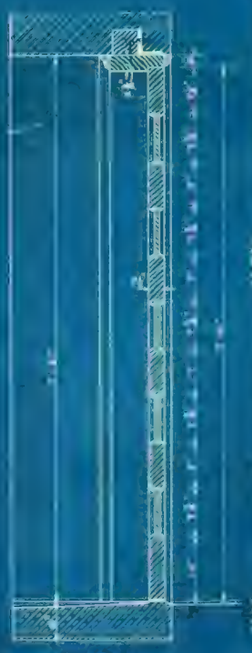
MIDDLE
BAR

ALE DETAILS

PLAN

PLAN

ELEVATION



SECTION

DETAIL OF REAR DOOR SOUTH ELEVATION
1 WANTED

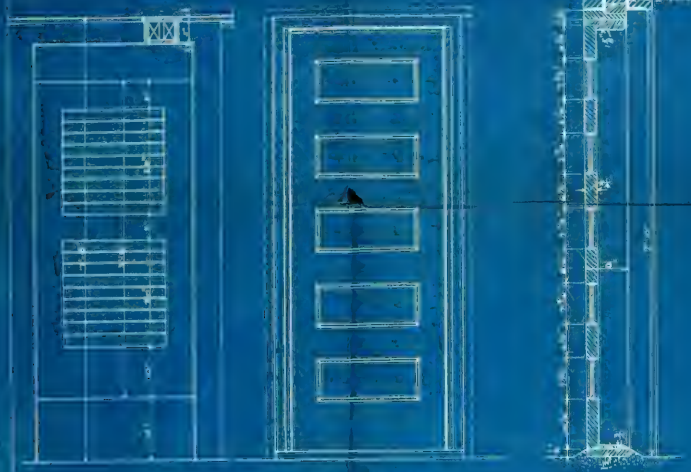
DETAIL OF WINDOW
& TRIM IN OFFICE
1 WANTED

ELEVATION

CHICAGO RAILWAYS CO.
CHICAGO, ILL.
MILL DETAILS
SUB STATION
LILL AVE

PLAN

PLAN



ELEVATION

SECTION

DETAIL OF LOUVRE DOOR IN TOILET ROOM 1 WANTED

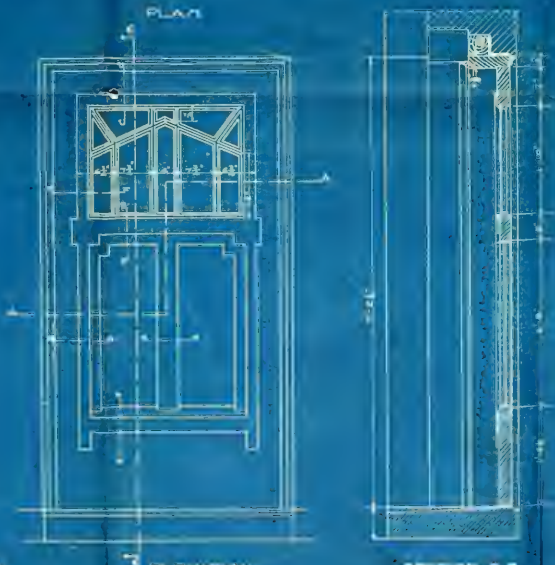
DETAIL OF DOORS IN AIR LOCK 2 WANTED

ELEVATION

SECTION

DETAIL OF DOORS IN BASEMENT EXCEPT IN AIR LOCK 4 WANTED

PLAN



ELEVATION

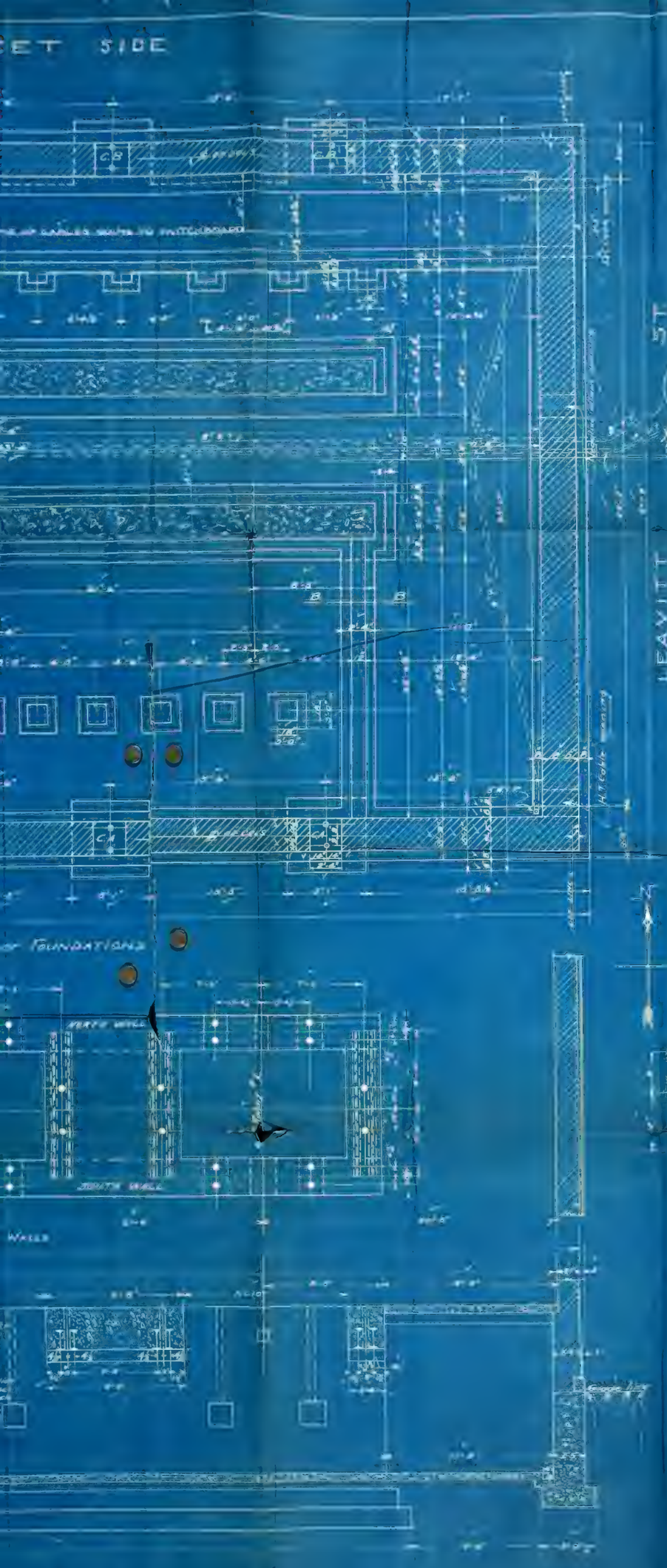
SECTION E-E

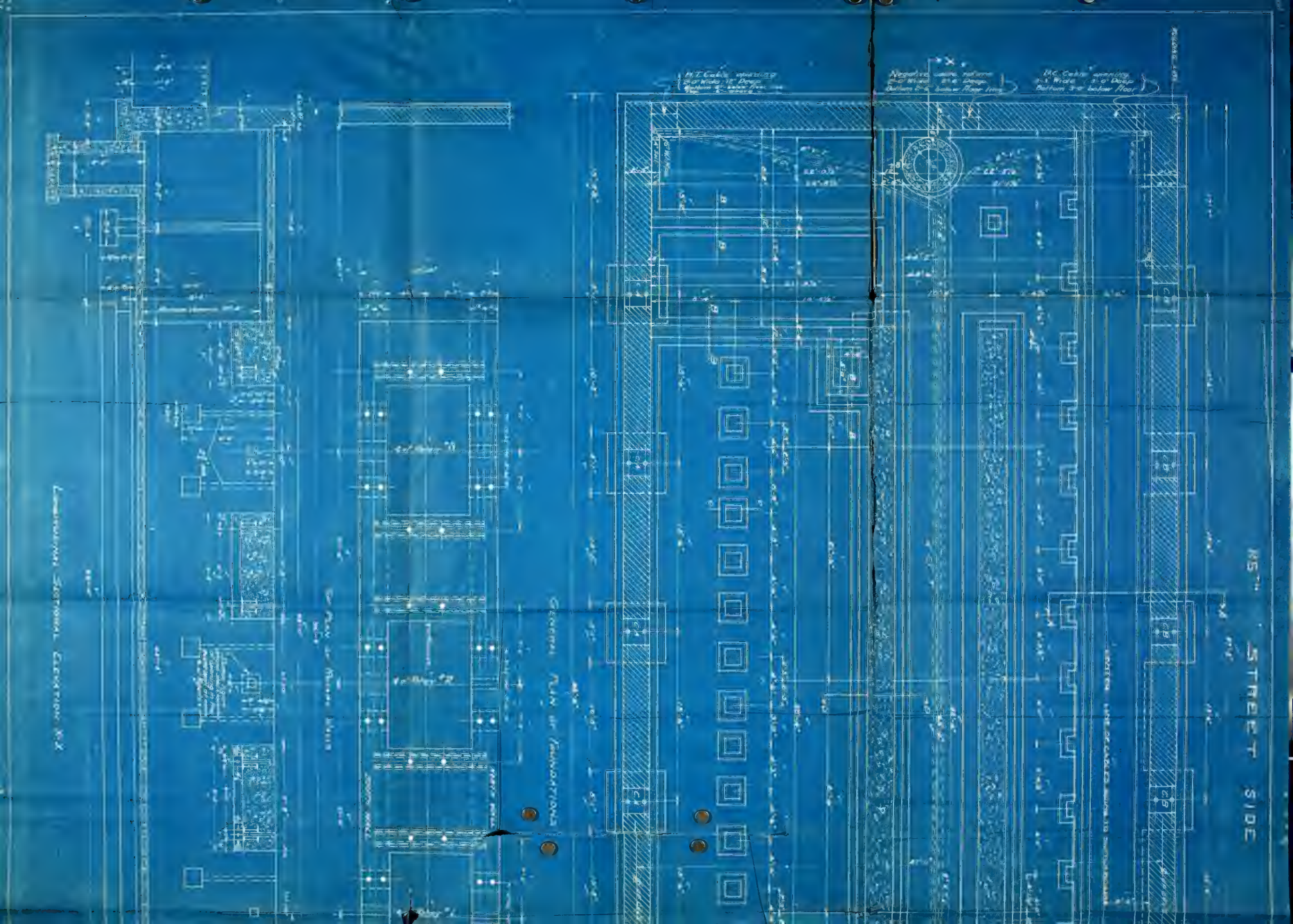
DETAIL OF ENTRANCE DOOR ON LILL AVE

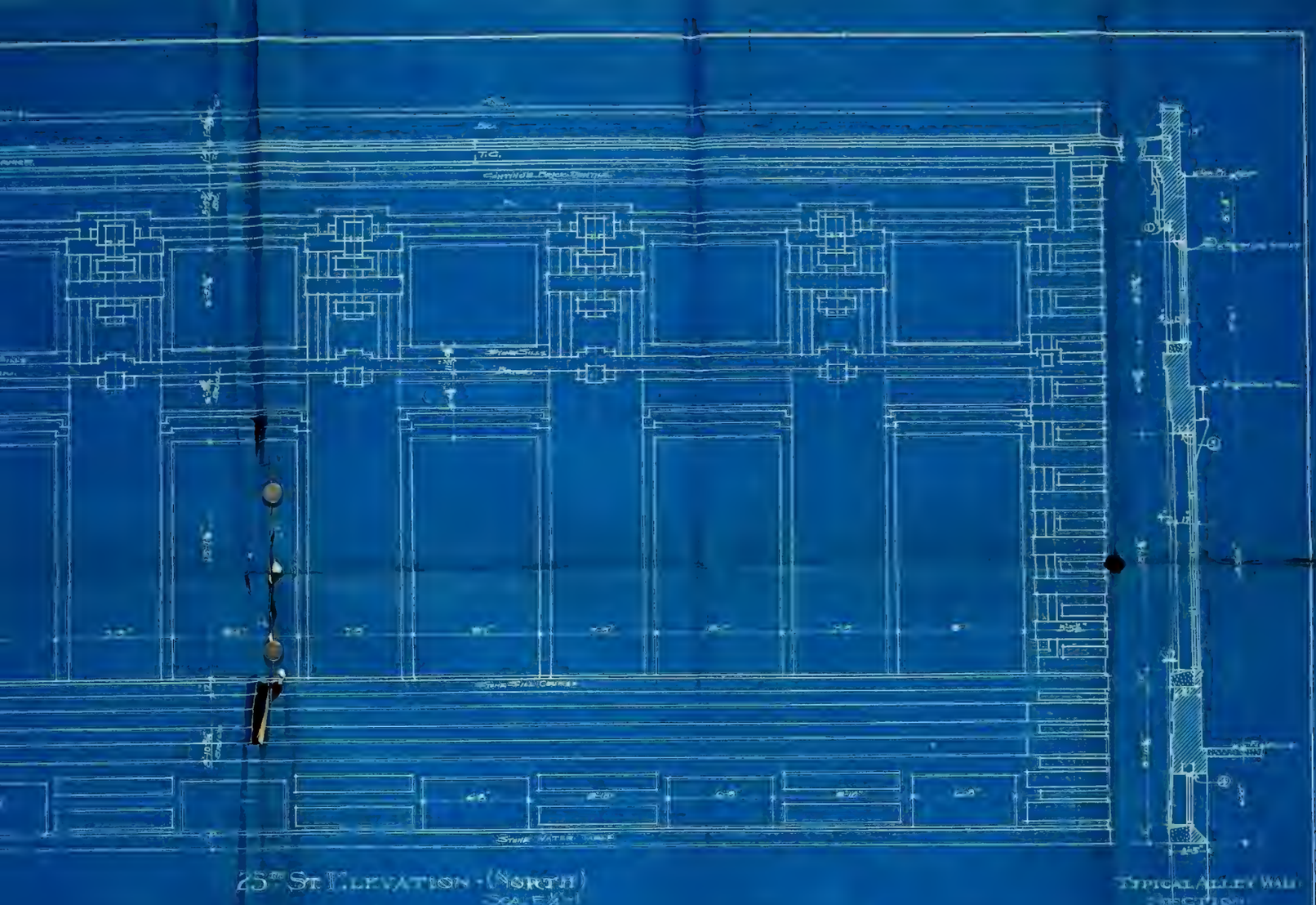
1 WANTED

HALF SIZE SCALE DETAILS

ET SIDE

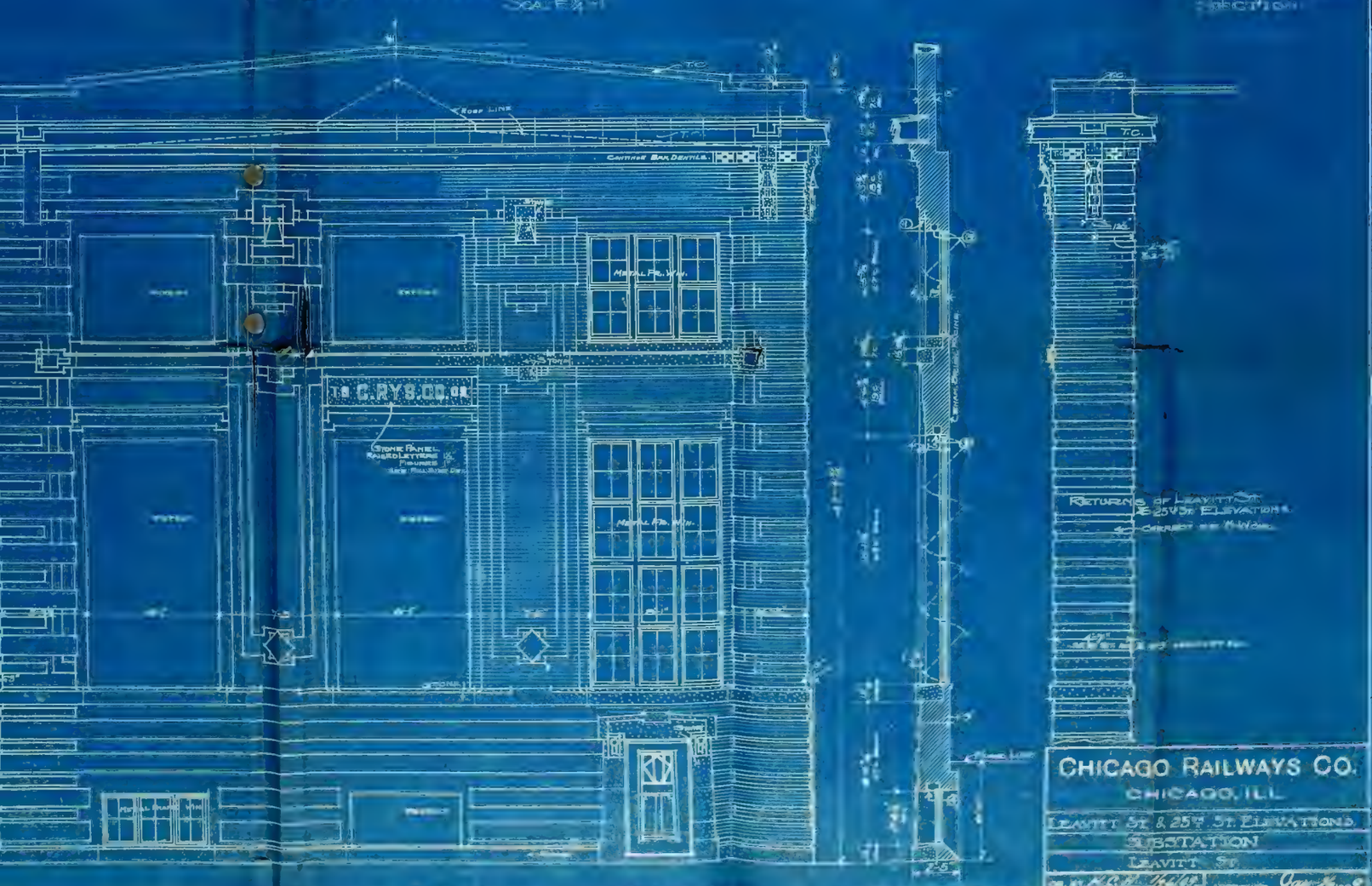

LEAVITT ST.
Section C-C
Section Through Wall
Section D-D
Floor line
Section Through Rotary Walls
Section Through Beam
Section through Slab
Section B-B
Section E-E
CHICAGO RAILWAYS CO.
CHICAGO, ILL.
FOUNDATION PLAN
LEAVITT ST. SUBSTATION
LEAVITT AND 25TH ST.
DR. BY
TR. BY
CK. BY
SCALE
REVISIONS
APPROVED
CHIEF ENGINEER
W.O. NO.
DWG. NO. D-1452


M.T. Cable opening
Negative cable return
M.C. Cable opening
Longitudinal Sectional Elevation N-S
General Plan of Foundations
45th Street Side



25th St. Elevation - (North)
SCALE 1/4"=1'

Typical Alley Wall Section

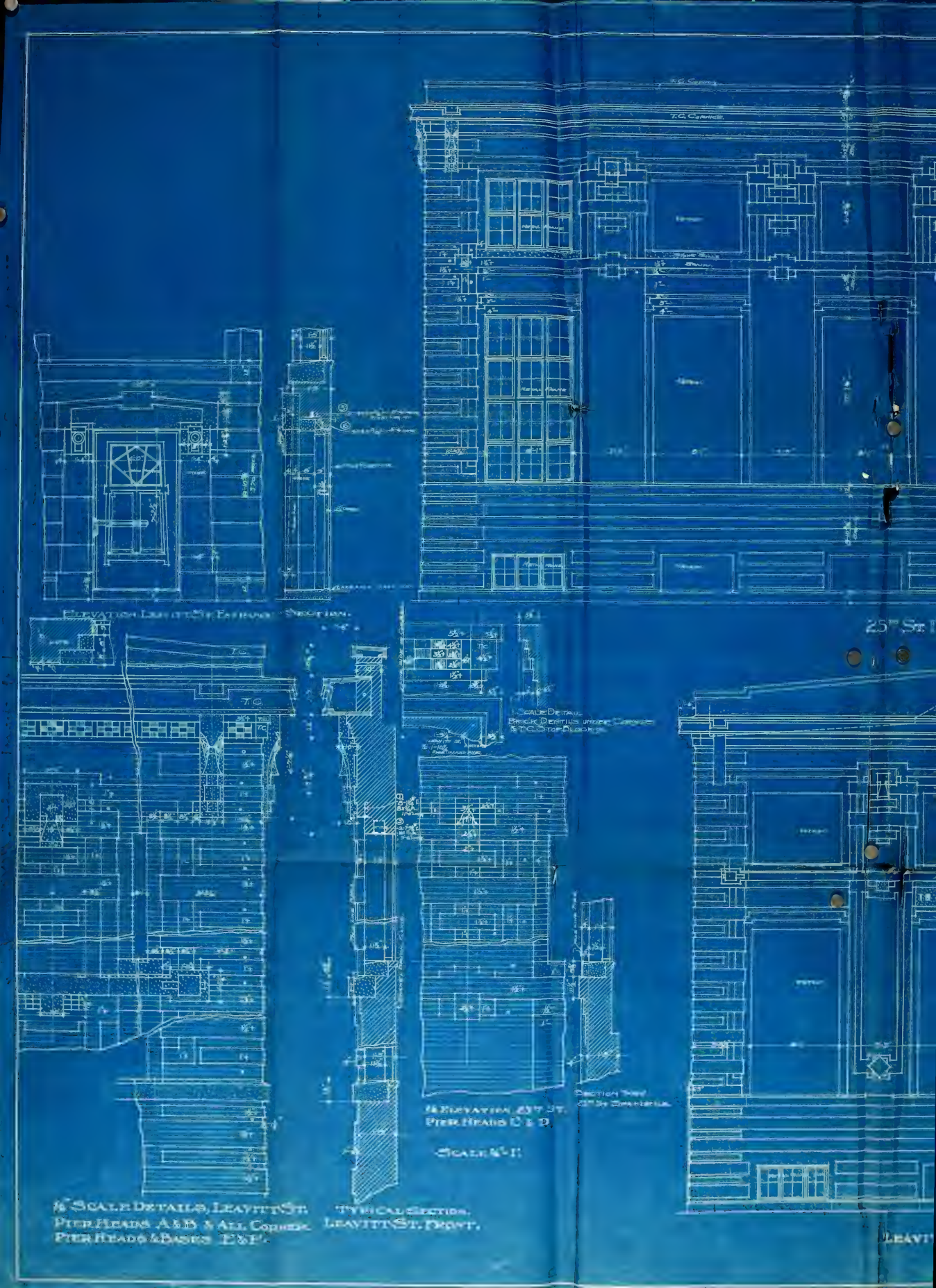


Leavitt St. Elevation (East)
SCALE 1/4"=1'

Leavitt St. Wall Section on ℄

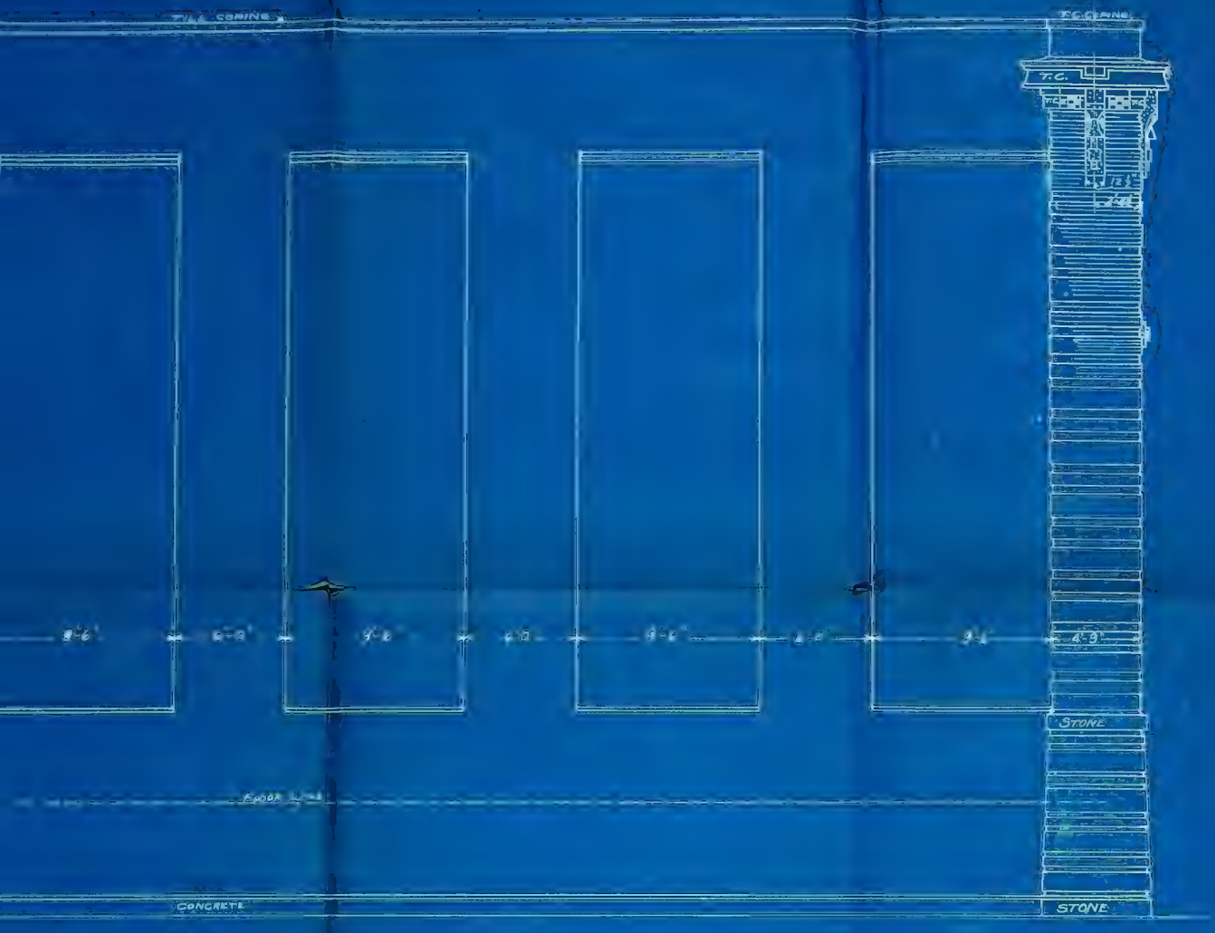
Returns of Leavitt St. & 25th St. Elevations

CHICAGO RAILWAYS CO.
CHICAGO, ILL.
LEAVITT ST. & 25TH ST. ELEVATIONS
SUBSTATION
LEAVITT ST.
DR. BY
TR. BY
CK. BY
SCALE
APPROVED
CHIEF ENGINEER
DATE

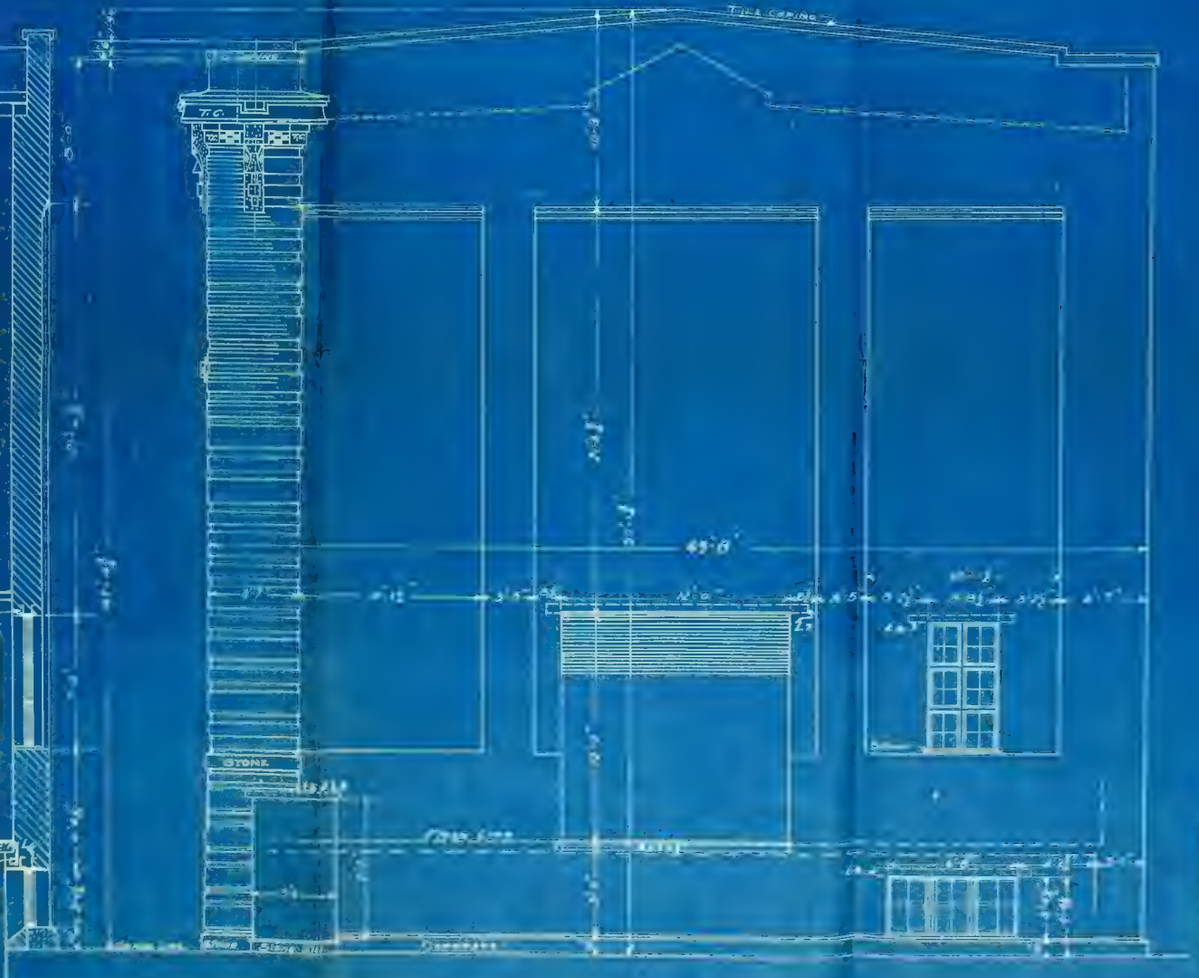


½" Scale Details, Leavitt St.
Pier Heads A & B & All Cornice,
Pier Heads & Bases E & F.

Typical Section,
Leavitt St. Front.

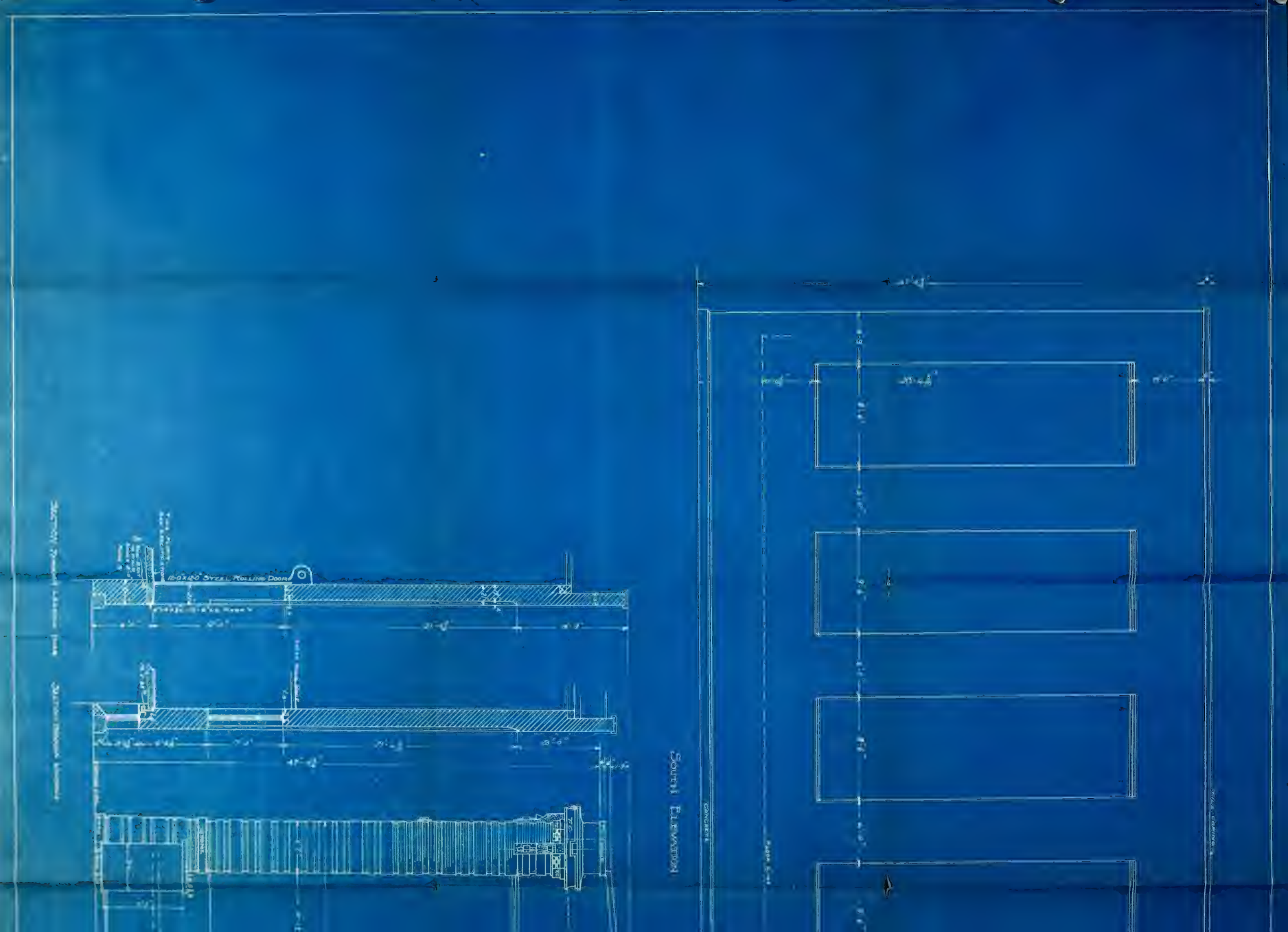


South Elevation



West Elevation

CHICAGO RAILWAYS CO.
CHICAGO, ILL.
SOUTH & WEST ELEVATIONS
SUBSTATION
LEAVITT ST.
Jan. 28, 1907
CHIEF ENGINEER
D-1452


South Elevation

ROLL JOINTS

SECTION OF COPING

LEAVITT ST ELEV.

RETURN

LEAVITT ST ELEVATION

STONE PARAPET

NOTE
PCS. 1 & 28, 75 & 81
TO BE CHECKED OUT FOR
S.E. LOCKOUT RODS, PLATES
AND ANCHORS FURNISHED BY
THE NORTHWESTERN TERRA
COTTA COMPANY

SECTION

CHICAGO RAILWAYS CO.
CHICAGO, ILL.

SUBSTATION
28TH & LEAVITT STS.

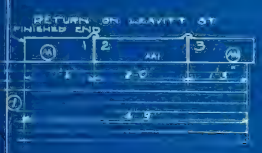
DR. BY TERRA COTTA CO.
TR. BY W.E.S.
CK. BY
SCALE 3/4" = 1'-0"
REVISED

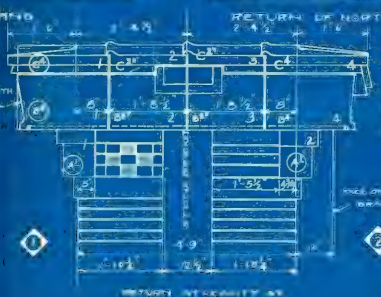
APPROVED 3/10 1913
W.O. NO.
DWG. NO. D-1455

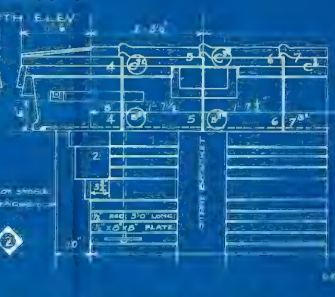
IIAA.

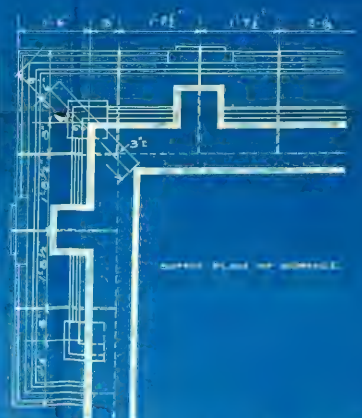
Leavitt St [East] Elevation of Coping

IIC
IIB
IIA

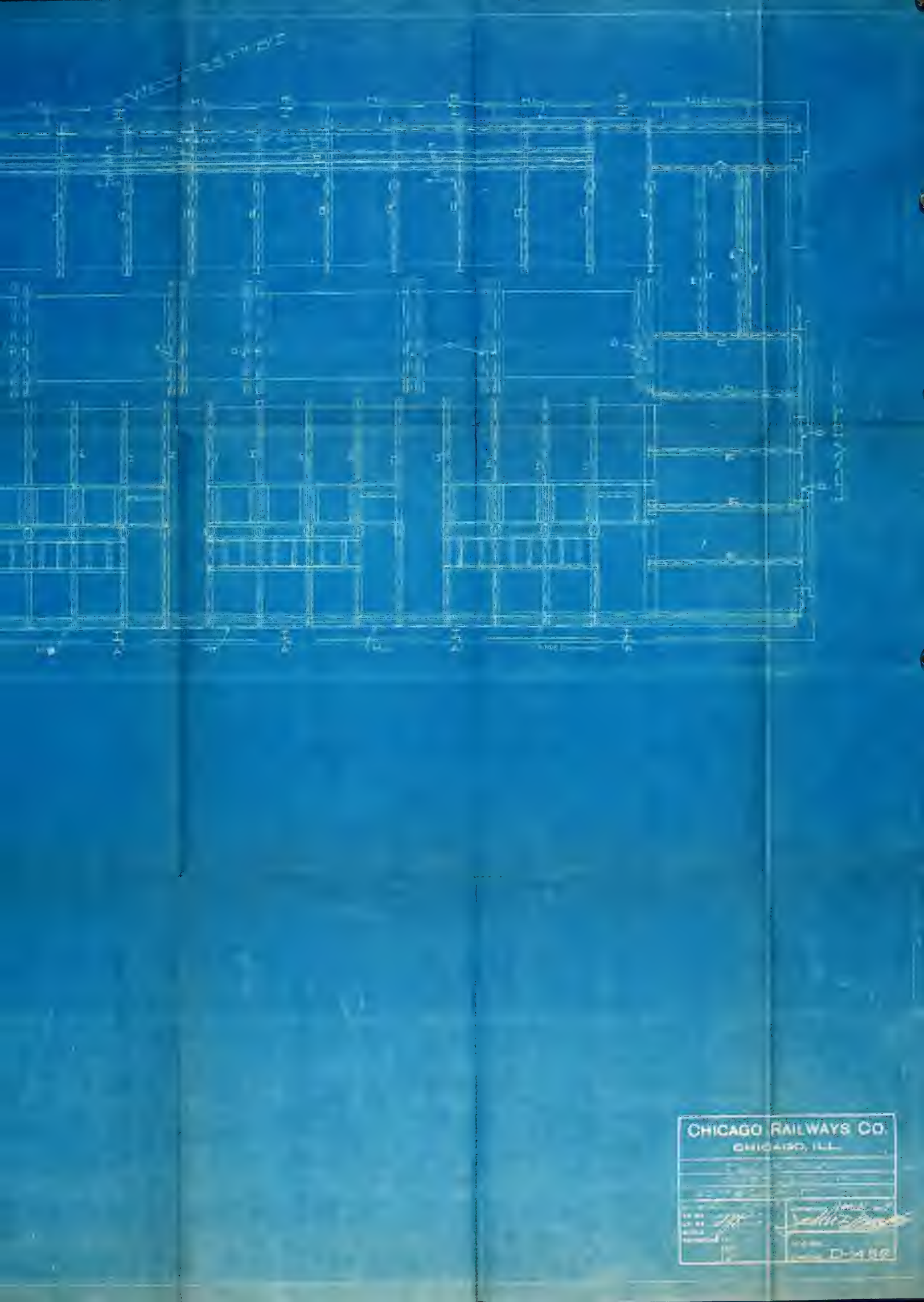




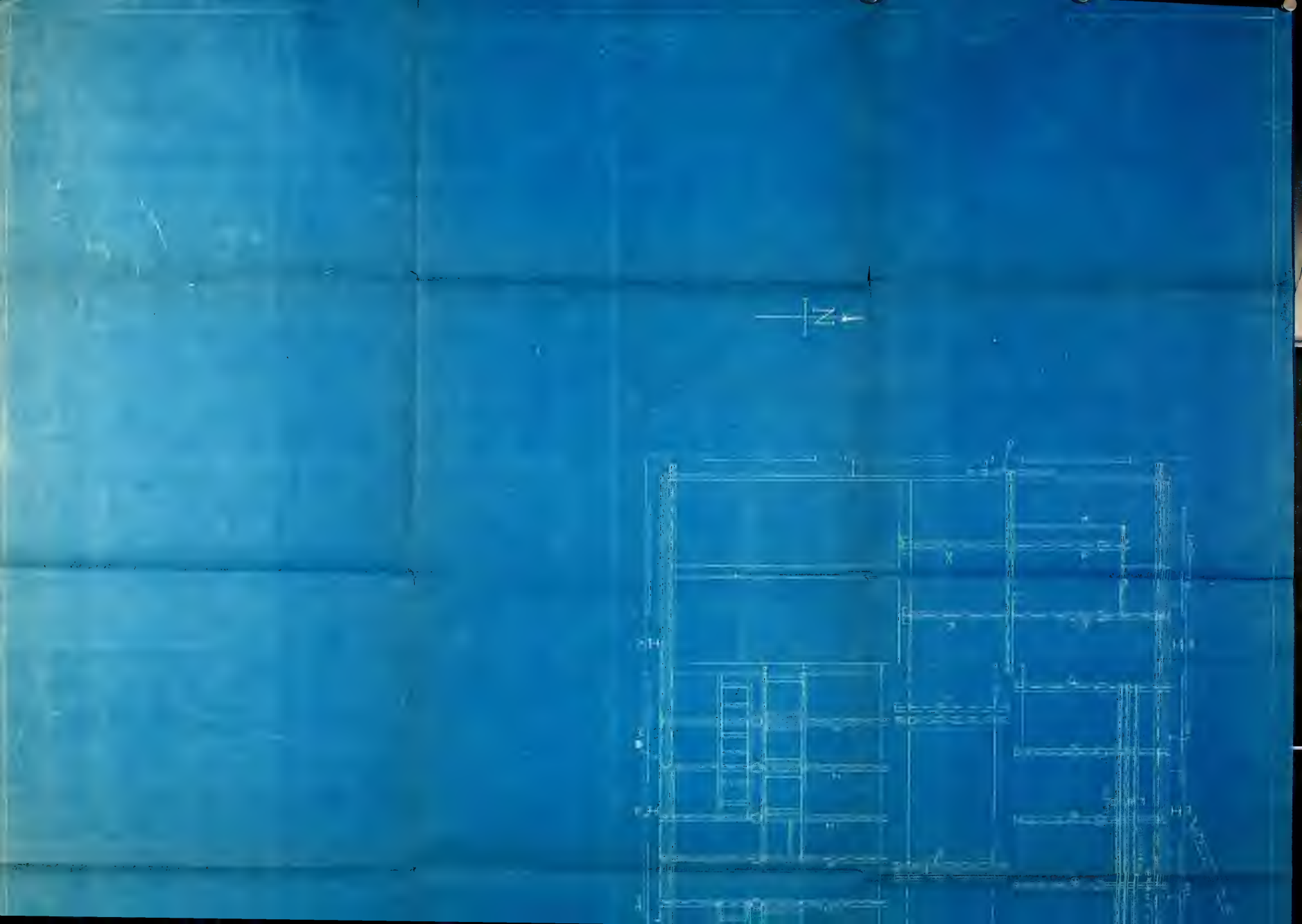




NOTE.
PCS. 1-4-28-29-31
TO BE CHECKED OUT F
ST. LOOKOUT BRACKETS
AND ANCHORS FURNISHE
THE NORTHWESTERN T
COTTLE COMPANY



CHICAGO RAILWAYS CO.
CHICAGO, ILL.



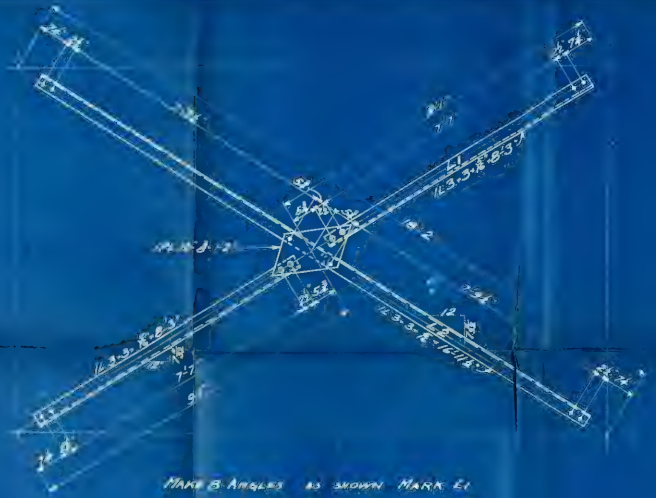
ROOF TRUSS - 4 REQD - AS SHOWN AND NOTED - MARKED T1.
ROOF TRUSS - 1 REQD - AS SHOWN AND NOTED - MARKED T2.

Note
Rivets 3/4" Diam.
Holes 7/8" Diam.
Paint 1 Coat Dixon Graphite Paint

Trusses
for
35th and Leavitt Str.
Sub Station
for
Chicago Railways Co.
George W. Jackson Inc.
Sheet No. 3 Contract No. 577

Approved
Approved by C.Ry.Co. 1/16/19

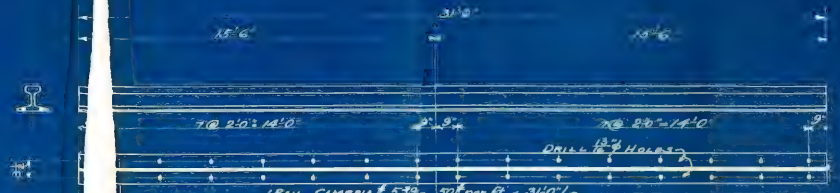
George W. Jackson
Pres. & Engr.



MAKE 8 ANGLES AS SHOWN MARK L1
MAKE 8 ANGLES AS SHOWN MARK L2

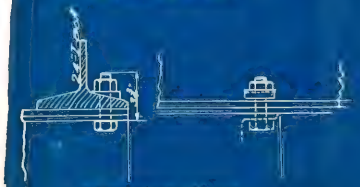
LIST OF FIELD RIVETS			
¾" DIA		⅞" DIA	
No. REQ'D	LENGTH	No. REQ'D	LENGTH
200	2"	10	2"
375	2½	200	2½
300	3½	50	3½
60	2½		
95	3½		
155	3½		
40	4½		

ADD STIFFENER CLIPS AND PILOTING TO L1-L2 AS SHOWN



MAKE 6 CRANE RAILS AS SHOWN MARK CR.

194 BOLTS ¾" ϕ - 3½" Lg.
WITH SQUARE WASHERS AS SHOWN



21 BOLTS ¾" ϕ 3½" Long
WITH SQUARE WASHERS AS SHOWN

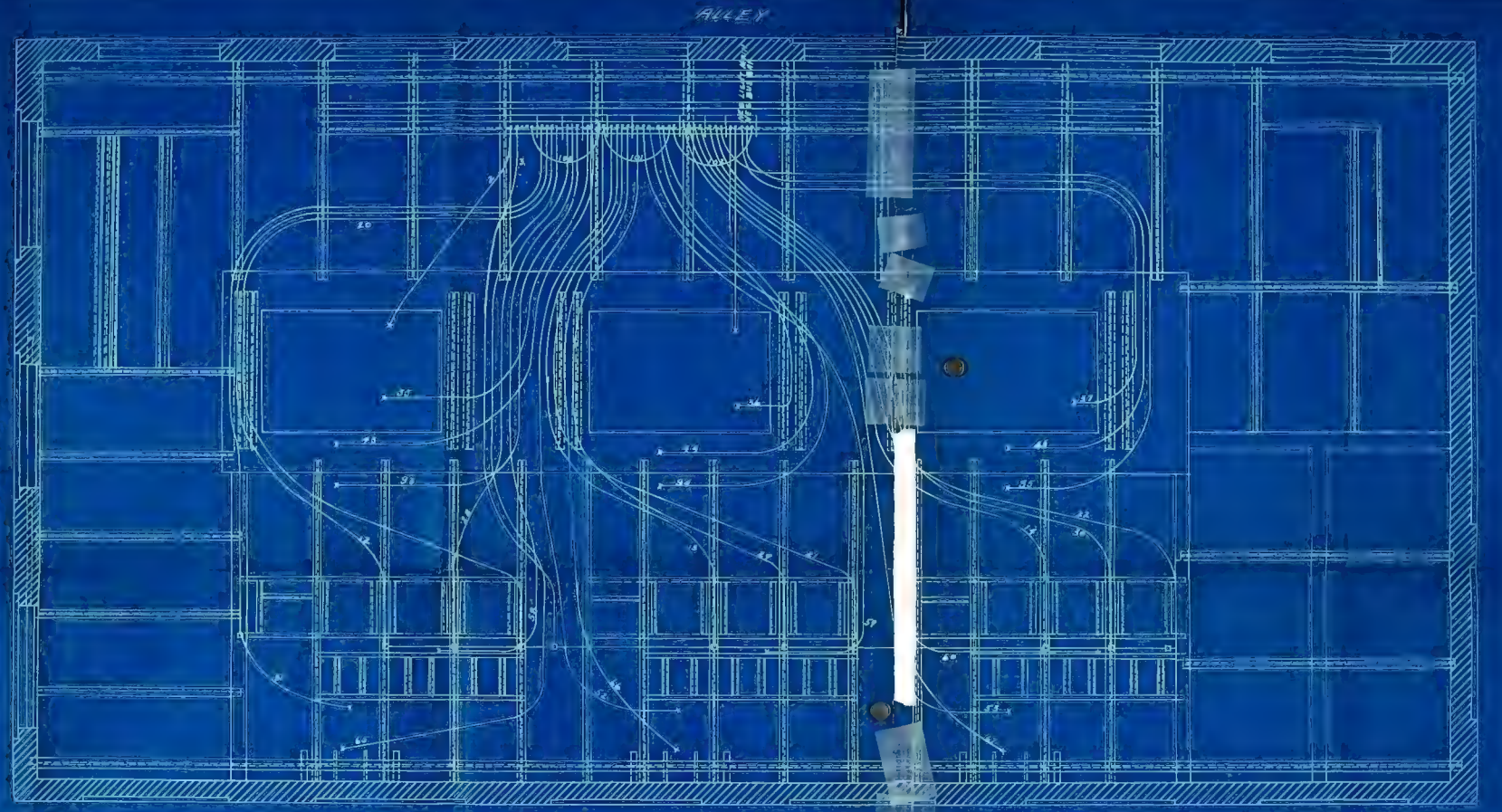
GENERAL NOTE
RIVETS ¾" DIA.
OPEN HOLES 13/16"ϕ
MARKING MUST BE PLAIN
PAINT: 1 COAT DIXONS GRAPHITE
INACCESSIBLE PARTS TWO COATS

Structural Steel
for
25th and Leavitt Sts
Sub Station
for
Chicago Railways Co
George W. Jackson Inc

Sheet No 6 Contract No 56

SUPERSEDES

PITTSBURGH



CONDUITS AND WIRES — LENGTH INCLUDES 10% EXTRA

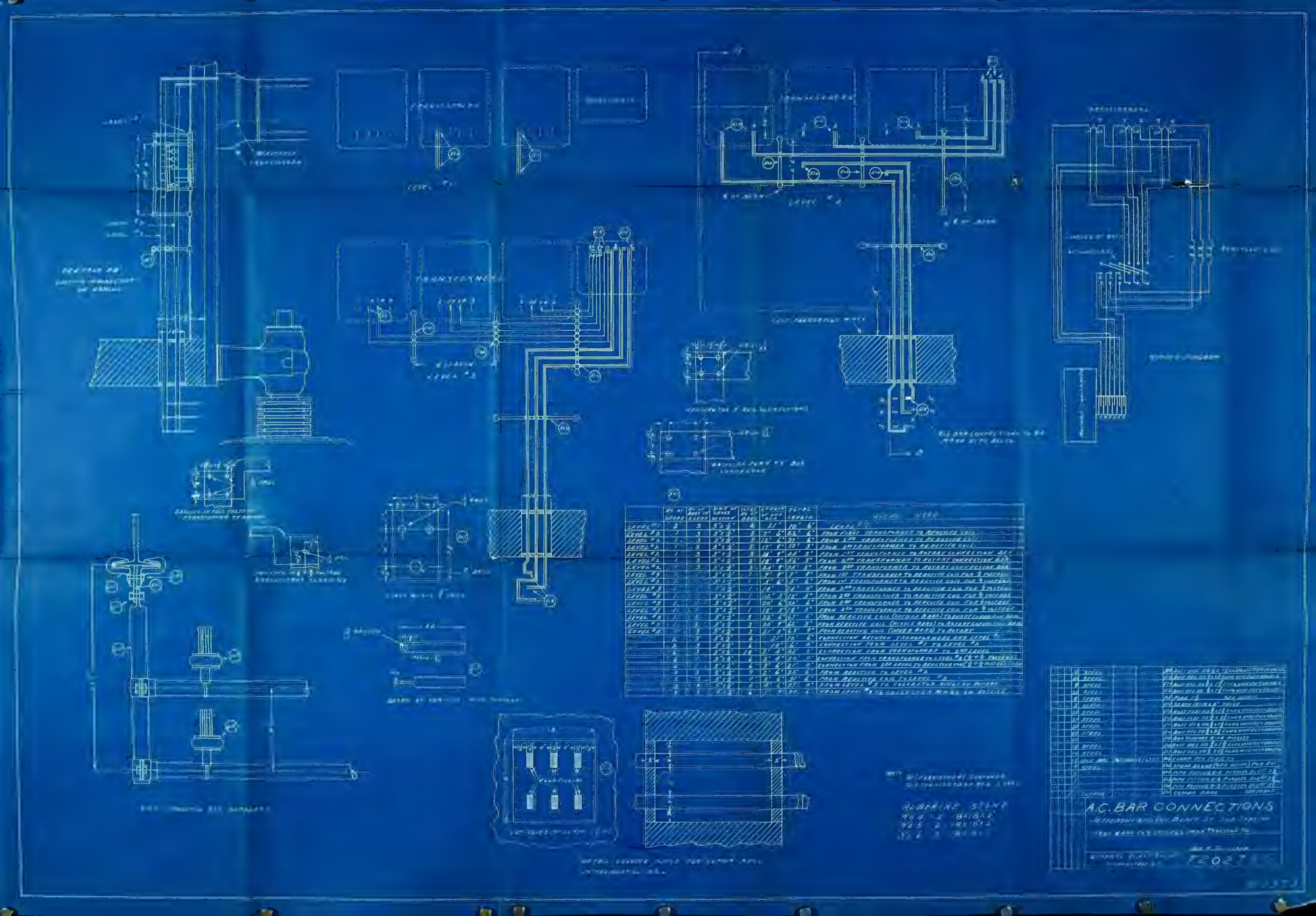
CONDUITS						WIRES				
REFERENCE NUMBER	NO. OF WELLS	PER METAL	PER FIBRE	SIZE	TOTAL LENGTH	WIRES PER CIRCUIT	SIZE & KIND	DIA.	INSULATION	TOTAL LENGTH
				1/2		2	#2 B&S	.292	RUB.+BRAID	
A				1		1	#2 "	.292	"	
B				1/2		2	#4 "	.232	"	
C				1/2		2	#4 "	.232	"	
5 TO 10				1/2		2	#10 ASS.TWIN	.116	"	
12 TO 14	3			1		2	#10 "	.116	"	
20 TO 22	3			1		2	#10 "	.116	"	
28 TO 30	3			1		2	#10 "	.116	"	
35 TO 37	3			3/4		2	#10 "	.116	"	
43 TO 45	3			3/4		2	#10 "	.116	"	
51 TO 53	3			1 1/4		4	#8 ASS.CWD.	.116	"	
58 TO 60	3			3/4		2	#10 B&S	.116	"	
65 TO 67	3			1 1/4		3	#10 ASS.TWIN	.116	"	
				1 1/2		4	#8 B&S	.116	"	
				1		1	#1 "	.145	"	
				1		1	#0 "	.148	"	
				1 1/2		6	#8 "	.148	"	
				1 1/4		3	#8 "	.148	"	
				1 1/4		2	#8 "	.148	"	
				1		1	#4 "	.232	VAR. COMP'D.	
93 TO 95	3			1/4		1	#10 TRIPLE			
101 TO 103	3			3/4		3	#8 B&S			

	WERE USED.
	A.B.S. TO BATTERY PANEL
	BATTERY PANEL TO NEGATIVE BUS
	" " " OIL SWITCH "
	OIL SWITCH BUS
	" " TO MOTOR
	A.T.F. " " TO LINE SWITCH MOTOR
	A.T.F. " " TIE
	A.M.R. " " CONVERTERS SWITCH MOTOR
	C.S.R. " " CONVERTER FIELD
	C.S.R. " " SPEED LIMIT SWITCH
	CURRENT TRANS. TO A.T.F. PANEL
	" " " A.M.R. "
	POTENTIAL " " A.T.F. "
	" " " OIL SWITCH A.M.R. PANEL
	JUNCTION BOX 'E' TO 'F'
	" " 'F' TO 'G'
	" " 'G' TO 'H'
	JUNCTION BOX 'H' TO FLOWER MOTOR TUNNEL
	TAPS FROM LINE TO POTEN. TRANS. POLES.
	POWER FACTOR INDICATOR
	LIGHT CIRCUIT

CHICAGO RAILWAYS CO.
CHICAGO, ILL.

CONDUITS AND WIRES
LILL AVE. SUBSTATION
LILL AVE.

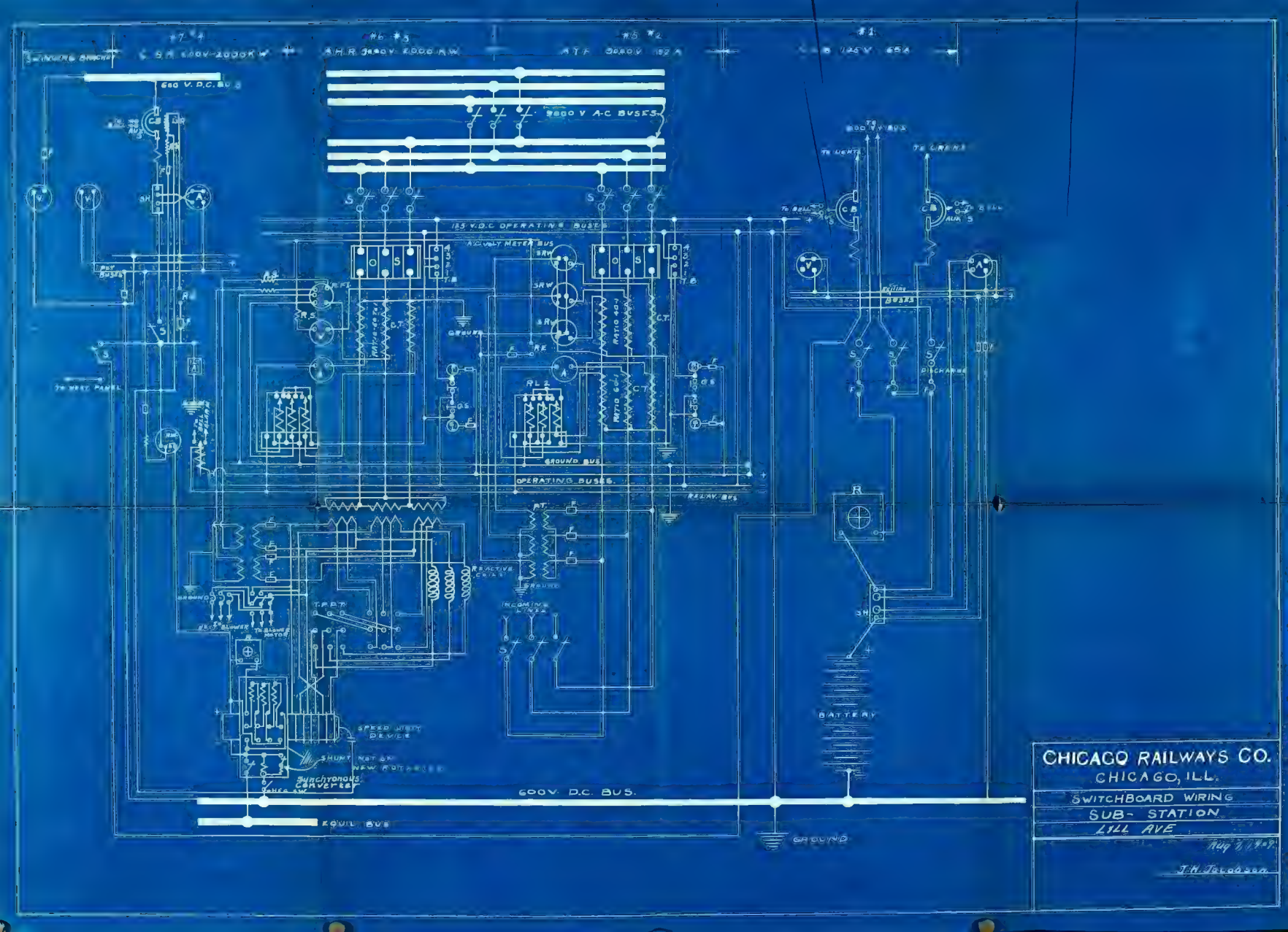
JOS. H. JACOBS.

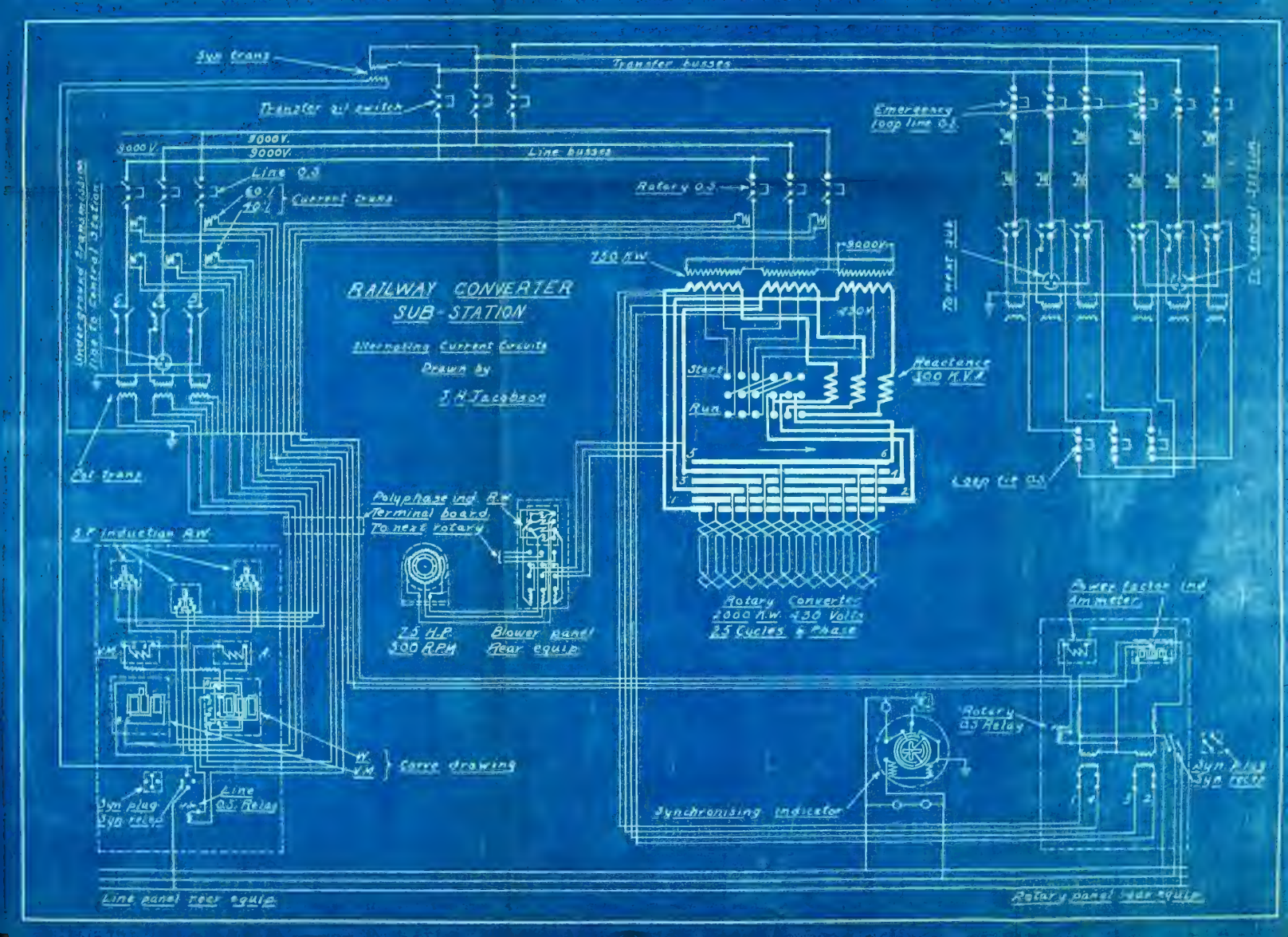


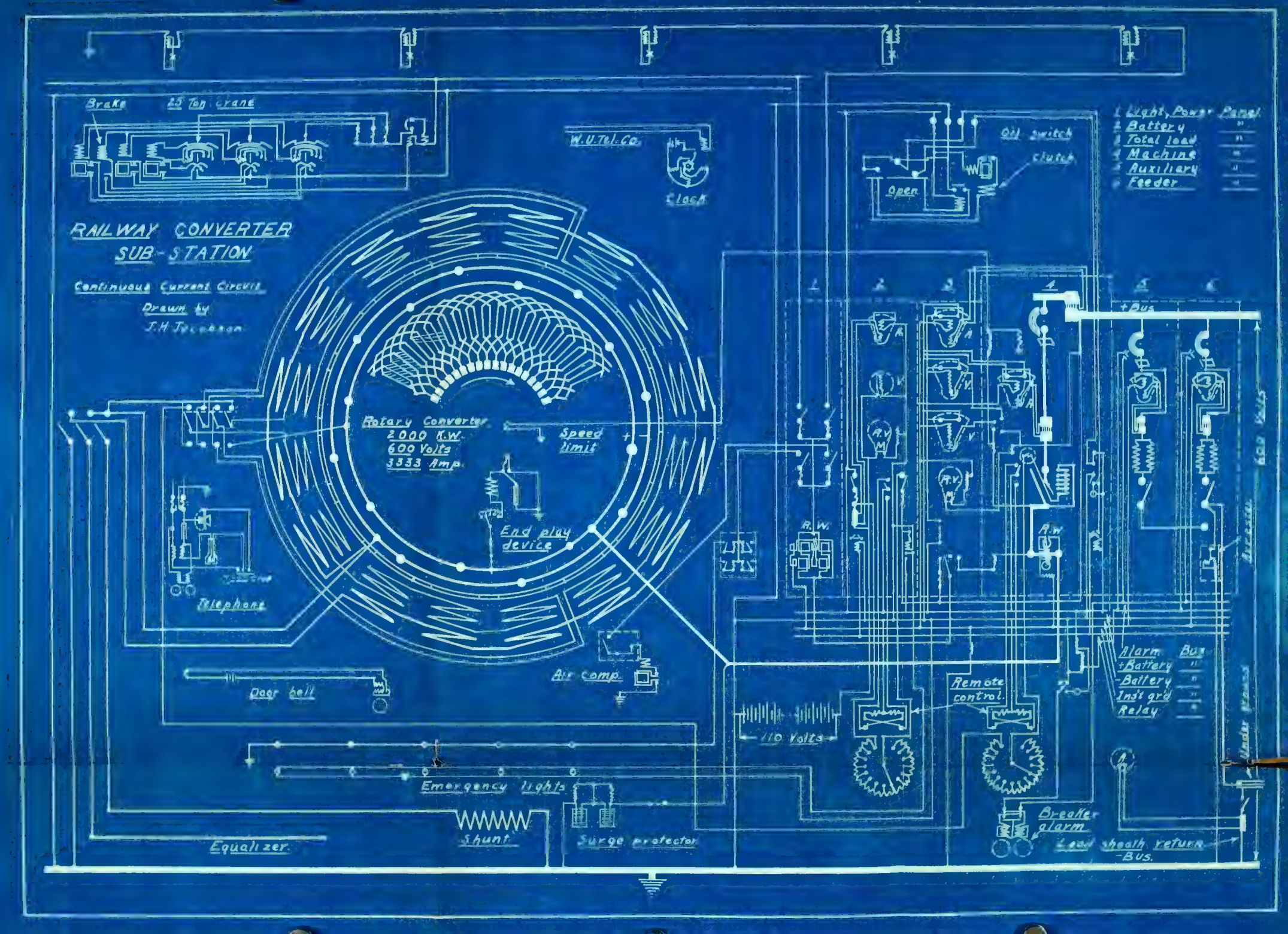
A.C. BAR CONNECTIONS

JEFFERSON AND DIV. BOND ST. SUB STATION

FEB 27

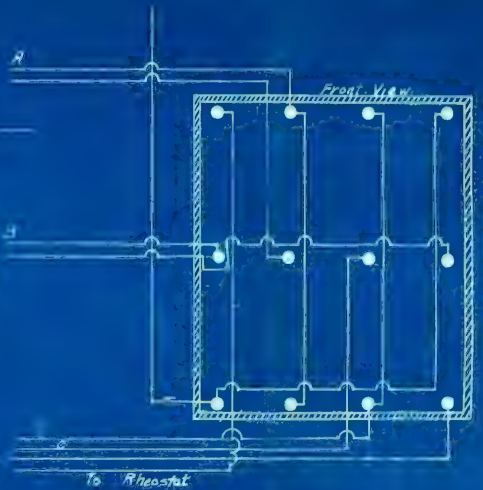

600 V. D.C. BUS
2300 V A-C BUSES
125 V.D.C. OPERATING BUSES
A.C. VOLT METER BUS
GROUND BUS
OPERATING BUSES.
RELAY BUS
600V. D.C. BUS.
EQUIL. BUS
GROUND
BATTERY
CHICAGO RAILWAYS CO.
CHICAGO, ILL.
SWITCHBOARD WIRING
SUB- STATION
LILL AVE.


Syn trans
Transfer bussers
Transfer o.l switch
Emergency loop line o.l.
3000 V.
3000V.
Line bussers
Line o.l
Rotary o.l
Current trans.
Underground transmission line to Central Station
750 K.W.
3000V
RAILWAY CONVERTER SUB-STATION
Alternating Current Circuits
Drawn by
J. H. Jacobson
To next sub
Start
Run
Reactance 100 K.V.A.
Exc trans
Loop tie o.l.
Polyphase ind. A.M.
Terminal board.
To next rotary
S.P. induction A.M.
Rotary Converter
2000 K.W. 430 Volts
25 Cycles 4 Phase
25 H.P.
300 R.P.M.
Blower panel
Rear equip
Power factor ind.
Ammeter
Rotary o.l Relay
Syn plug
Syn recep
Line o.l. Relay
Synchronising indicator
Curve drawing
Line panel rear equip
Rotary panel rear equip


Brake
25 Ton Crane
W.U.Tel.Co.
Clock
RAILWAY CONVERTER SUB-STATION
Continuous Current Circuit
Drawn by
J.H. Jacobson
Rotary Converter
2000 K.W.
600 Volts
3333 Amp.
Speed limit
End play device
Telephone
Door bell
Air Comp.
Emergency lights
Shunt
Surge protector
Equalizer
110 Volts
Oil switch
Clutch
Open
Light, Power Panel
Battery
Total load
Machine
Auxiliary
Feeder
+Bus
A.V.
A.W.
Remote control.
Alarm Bus
+Battery
-Battery
Ins't grd
Relay
Breaker alarm
Lead sheath return
-Bus.

NOTE

FOR COUNTER-CLOCKWISE ROTATION OF ARMATURE REVERSE BOTH THE SHUNT & SERIES FIELD LEADS & REVERSE BRUSH HOLDERS ON STUDS KEEPING EACH INDIVIDUAL BRUSH IN SAME NEUTRAL POINT AS FOR CLOCKWISE ROTATION



Field Break Up Switch

COMMUTATOR END

DEVELOPMENT OF LOWER SPOOLS LOOKING FROM INSIDE OF MACHINE

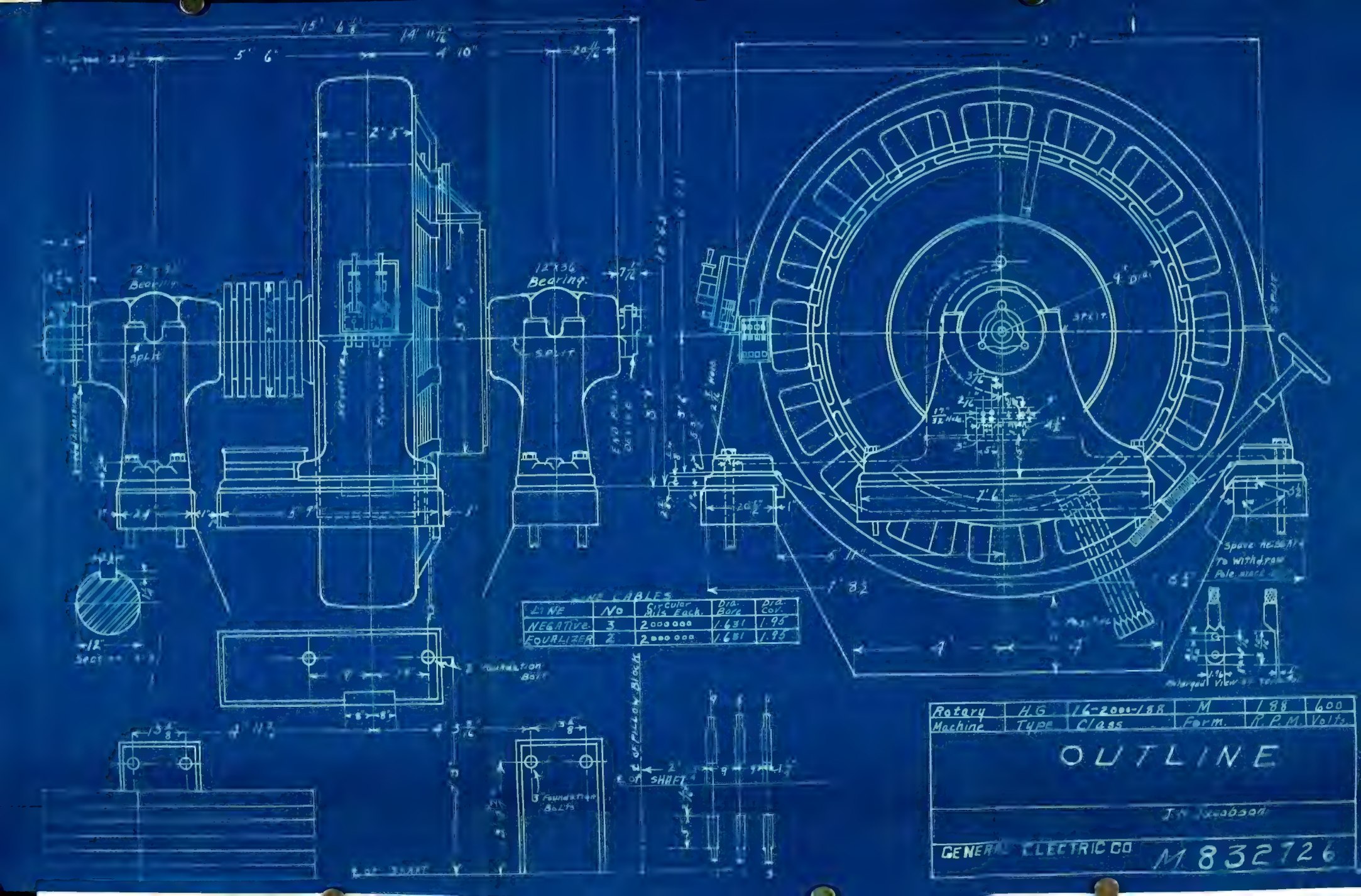
DIAGRAM OF CONNECTIONS

FIRST MADE FOR ROT CON H C 1/G 2000-88 L-6 A 0 1

J Jacobsm

G.E Co.
SCHENECTADY N.Y.

M 832732



CABLES

LINE	No	Circular Mils Each.	Dia. Bare	Dia. Cov.
NEGATIVE	3	2000000	1.631	1.95
EQUALIZER	2	2000000	1.631	1.95

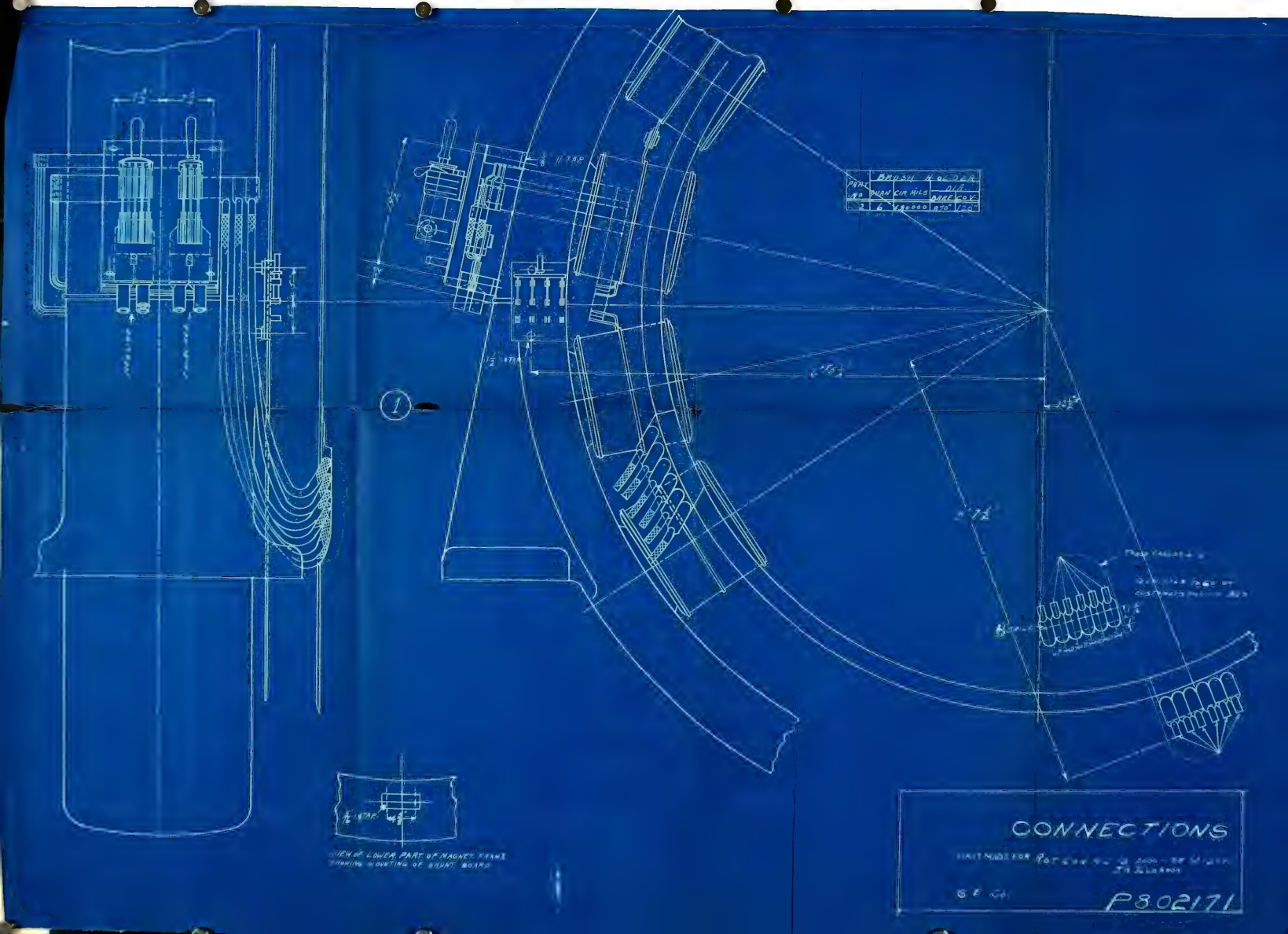
Rotary Machine	H.G Type	14-2000-128 Class	M Form.	188 R.P.M	600 Volts

OUTLINE

J.H. Hobson

GENERAL ELECTRIC CO

M 832726


BRUSH NO. 0-A-A
PART NO.
QUAN
CIR MILS
ARMATURE
CONNECTIONS
G E Co
P802171

Sectionized Map

C. R y s Co. & C. C. T. Co

- 1909 -

REVISED